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TF 2015A

AM/FM SIGNAL GENERATOR

Instruction Manual

MP MASTER
MA23627

AM/FM Signal Generator

TF 2015A

Code No. 52015-304M

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MARCONI INSTRUMENTS LIMITED
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Note ...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ► ..... ◄ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

WARNING : HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

Chapter 1

GENERAL INFORMATION

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1 10 MHz - 520 MHz AM/FM Signal Generator TF 2015A 1

INTRODUCTION

1. TF 2015A is a general purpose a.m./f.m. signal generator covering the frequency range 10 MHz to 520 MHz in eleven switched bands. Fundamental frequency generation is by voltage tuned oscillators which, in conjunction with the panel mounted controls, enable easy tuning to narrow band communication receivers up to the highest carrier frequencies.

Fig. 1 10 MHz - 520 MHz AM/FM Signal Generator TF 2015A.

2. Outputs up to 200 mV e.m.f. can be obtained with up to 80% a.m. or up to 400 mV e.m.f. for c.w. or f.m. Output is maintained constant over the whole frequency range by an automatic level control loop and is adjustable by coarse and fine attenuators calibrated in dBm in 50 Ω. An auxiliary output is available for driving a counter or digital synchronizer.

3. Amplitude modulation and frequency modulation are both derived from an internal 1 kHz oscillator. AM depth is variable up to 80% by a directly calibrated control. FM is directly calibrated in two full-scale ranges of 10 kHz and 100 kHz peak deviation. External modulation may also be applied and a mixed a.m. and f.m. facility is available.

4. The output circuit is protected from damage caused by accidental application of reverse power when testing low power transmitter/receivers.

5. The instrument, which is compact and portable, can be operated from a.c. supplies or from an external battery.

PERFORMANCE DATA

Characteristic	Performance
6. Frequency	
Range :	10 MHz to 520 MHz in 11 ranges :
	10.0 MHz to 14.3 MHz — 86 MHz to 124 MHz 14.3 MHz to 20.5 MHz — 124 MHz to 177 MHz 20.5 MHz to 29.4 MHz — 177 MHz to 254 MHz 29.4 MHz to 42.0 MHz — 254 MHz to 363 MHz 42.0 MHz to 60.0 MHz — 363 MHz to 520 MHz 60.0 MHz to 86.0 MHz
Discrimination :	Suitable for tuning into a receiver with a 6 kHz bandwidth (±3 kHz at -3 dB points).
Calibration accuracy :	±1.5% with extra fine tune control centred.
Stability :	At a constant ambient temperature in the range +10°C to +35°C and after 2 hours from switch on the drift does not exceed 2 parts in 10^5 in 5 minutes.
7. RF output	
Level :	-127 dBm to -7 dBm (0.2 μV to 200 mV e.m.f.) with up to 80% a.m. : up to -1 dBm (400 mV e.m.f.) with no a.m.
Attenuators :	Coarse : 11 steps of 10 dB. Fine : 0 to 10 dB continuously variable, directly calibrated in dBm.
ALC :	With a terminated output, automatic level control maintains the level meter indication substantially constant.

Characteristic	Performance
Total level accuracy : (above 2 μV e.m.f.)	With carrier switch in the on position : ±1 dB up to 100 MHz ±2 dB above 100 MHz
Source impedance :	50 Ω v.s.w.r. better than 1.3 with 10 dB or more in the coarse attenuator.
Counter output :	Greater than 80 mV into 50 Ω.
Leakage radiation :	Up to 520 MHz with a receiver sensitivity set at 1.0 μV, a 1 inch 2-turn loop feeding the receiver cannot detect a signal of this level at a distance greater than 1 inch from generator. Allows measurements to be made on receivers with sensitivities down to 0.1 μV.

8. Amplitude modulation

Depth :	Continuously variable up to an indicated 80% by directly calibrated control.
Monitor :	Reference level indicator.
Calibration accuracy :	±5% modulation depth at an indicated 30% rising to ±10% modulation depth at an indicated 80%.
Envelope distortion :	Less than 5% at modulation depths up to 30%.
Internal frequency :	1 kHz ±10%.
AF output :	Fixed level greater than 1.5 V r.m.s. into 10 kΩ.
External frequency range :	50 Hz to 20 kHz.
External input requirement :	Less than 1.5 V r.m.s. into 1 kΩ to set reference level.

9. Frequency modulation

Deviation :	Continuously variable in two ranges with full-scale settings of 10 kHz and 100 kHz.
Frequency modulation performance :	Accuracy within ±15% of range full-scale at 1 kHz modulating frequency. Distortion less than 3% using internal modulating oscillator. However, between 11 MHz and 60 MHz the maximum deviation is 15 kHz for 3% distortion and ±15% accuracy. Within this frequency range deviation above 15 kHz may be subject to an additional 2% distortion and an additional -5% deviation error.
Monitor :	Reference level indicator.
Internal frequency :	1 kHz ±10%.
External frequency response characteristics :	50 Hz to 20 kHz within ±1 dB of the response at 1 kHz. Usable over modulation frequency range 30 Hz to 100 kHz.

Characteristic	Performance
External input requirement :	Less than 1.5 V r.m.s. into 1 kΩ to set reference level.
10. Spurious signals	
Carrier harmonics :	At least 26 dB below the carrier at output levels up to -7 dBm.
Non-harmonic components : (coherent)	None.
FM on c.w. :	With telephone psophometric weighting, equivalent deviation is less than 60 Hz up to 254 MHz and less than 100 Hz up to 520 MHz.
AM on c.w. :	Less than 0.2% modulation depth.
FM on a.m. :	With telephone psophometric weighting, less than 500 Hz deviation at 30% modulation depth with 1 kHz modulation frequency.
AM on f.m. :	With telephone psophometric weighting, at 30 kHz deviation, less than 3% a.m. above 21 MHz and 5% a.m. below.
11. Reverse power	Protects signal generator output from accidental r.f. power from a transmitter, rated 25 W maximum, over the frequency range 10 MHz to 520 MHz and d.c. voltages up to ±50 V.
12. Safety	Complies with IEC and BS 4743 Safety Requirements.
13. Radio frequency interference	Conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.
14. Power requirements	
AC mains :	Any voltage within the extreme limits 190 to 264 V or 95 to 132 V, at any frequency between 45 Hz and 500 Hz. Consumption : approx. 10 VA.
External d.c. :	24 V to 32 V (negative earth).
15. Limit range of operation	
Temperature :	0 to 55°C.
16. Conditions of storage and transport	
Temperature :	-40°C to +70°C.
Humidity :	Up to 90% relative humidity.
Altitude :	Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3.9 lbf/in^2).

Characteristic	Performance

17. Dimensions and weight

Height :	140 mm ($5\frac{1}{2}$ in).
Width :	286 mm ($11\frac{1}{4}$ in).
Depth :	311 mm ($12\frac{1}{4}$ in).
Weight :	5.4 kg (12 lb).

ACCESSORIES

18. Accessories supplied

	Part No.
Mains cable	43129-071D
Adapter BNC to TNC	23443-814X
RF cable TM 4969/3, BNC plug to BNC plug	43126-012S

19. Accessories available

	Part No.
Carrying case	41690-044B
Matching Unit TM 5569; a series 25 Ω resistor that converts the effective source impedance of the generator from 50 Ω to 75 Ω. BNC socket to Belling-Lee type L734/P plug.	44411-001M
Matching T pad TM 5573/3, for matching to 75 Ω loads Input/output voltage ratio 2:1. BNC plug to BNC socket.	44411-019G
20 dB attenuator pad TM 5573; BNC plug to BNC socket.	44425-501E
RF fuse unit TM 9884; for protecting external matching units when connecting to active loads. BNC plug to BNC socket.	43281-007C
455 kHz i.f. probe (each provides a crystal controlled signal at a standard i.f. for use in receiver alignment.)	54451-121B
470 kHz i.f. probe	54451-061Y
10.7 MHz i.f. probe	54451-071S
Conversion kit to give r.f. output units in μV, mV e.m.f.	46883-302M
Shelf rack mounting (single) (Fitting instructions for these are included in the kit.)	54127-231P
Shelf rack mounting (double)	54127-241A

Chapter 2

INSTALLATION

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1 Unpacking and repacking
2 Mains supply connector
3 Mains voltage selection
5 Battery operation
7 RF fuse

UNPACKING AND REPACKING

1. Retain the container, packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument. If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.

1) Place a pad in the bottom of the container.

2) Place pads in the front and rear ends of the container with the plywood load spreader(s) facing inwards.

3) Put the polythene cover over the instrument and place it in the container with the front handles and rear projections (where applicable) against the plywood load spreaders.

4) Place pads in the two sides of the container with cushioning facing inwards.

5) Place the top pad in position.

6) Wrap the container in waterproof paper and secure with adhesive tape.

7) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader is also advisable.

MAINS SUPPLY CONNECTOR

2. The a.c. supply lead is fitted at one end with a female plug which connects with the instrument. A suitable three pin mains plug must be connected to the other end. The colour coding

of the three wires is as follows :-

Brown	-	Live
Blue	-	Neutral
Green/Yellow	-	Earth

When attaching the mains lead to a non-soldered plug, it is recommended that the tinned ends of the leads are first cut off owing to the danger of cold flow resulting in intermittent connections.

MAINS VOLTAGE SELECTION

3. The TF 2015A may be operated from any voltage within the range 190 to 264 V or 95 to 132 V, 45 to 500 Hz. Voltage regulation eliminates the need for transformer tap changing except between the two ranges. The instrument is normally supplied for a.c. operation with mains fuses (FS1 and FS3) rated at 160 mA and with the mains selector switch set for voltages of 190 to 264 V.

4. To change to the lower voltage range proceed as follows :-

1) Remove the voltage selector switch locking plate.

2) Set the voltage selector switch to the 95 to 132 V position.

3) Reverse the locking plate and refit.

4) Fit mains fuses rated at 250 mA.

BATTERY OPERATION

5. For battery operation it is only required to connect a 24 V battery to the appropriate terminals located at the rear of the instrument. The battery input circuit incorporates a fuse (FS2) rated at 500 mA.

6. A mains/battery switch is not provided since this input functions automatically and the circuits are protected against reverse polarity. This feature could be used for emergency standby battery operation which would cut in automatically in the event of a mains supply failure.

RF FUSE

7. Although automatic protection from reverse power is incorporated within the TF 2015A, the optional accessory r.f. fuse TM 9884 should be used to protect external matching units when these are used in transceiver testing.

Chapter 3

OPERATION

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INTRODUCTION

1. As TF 2015A is a portable instrument, a removable cover is clasp fitted to the case to provide front panel protection and also stowage space for some accessories. A lifting foot fixed to the lower section of the case enables the instrument to be tilted for easy operation of the controls.

PRELIMINARY REQUIREMENTS

2. Prior to connecting the instrument to the a.c. mains supply check that :

   1) The voltage selector switch is set to accept the mains supply available.

   2) Fuses are of the required rating - see Chap. 2.

CONTROLS AND CONNECTORS

Front panel - Fig. 1

3. 1) AC SUPPLY switch. Positioned up to switch ON.

   2) PILOT LAMP. Lit when a.c. supply is switched on or when external battery is connected.

   3) CARRIER switch. Set at ON for normal c.w., f.m., or a.m. operation. The +6 dB position provides a high output for c.w. or f.m. only. The OFF position allows the carrier to be switched off without switching the instrument off.

   4) CARRIER RANGE switch. Selects the required frequency range and exposes the appropriate tuning scale.

Fig. 1 Front panel controls.

5) TUNE control. This is a nineteen position switch to set the generator approximately to the required frequency.

6) FINE TUNE control. Provides continuous tuning between each of the nineteen positions of 5) above.

7) EXTRA FINE TUNE control. An uncalibrated fine tuning control which allows very precise setting of the carrier frequency.

8) FUNCTION switch. Selects c.w., internal or external a.m. or f.m. or simultaneous f.m. and a.m.

9) DEVIATION control. Full-scale value is 10 or 100 kHz depending on setting of x1, x10 multiplier.

10) DEVIATION x1, x10. Multiplier for use with DEVIATION control.

11) SET MOD. control. Adjusted to set the pointer of the MOD and CARRIER LEVEL meter to the reference mark (centre of white box) for f.m. or a.m.

12) AM DEPTH. Adjusted to provide the desired a.m. depth from 0 to 80%.

13) MOD & CARRIER LEVEL meter. Indicates correct reference level for a.m. and f.m. and also correct a.l.c. operation in the c.w. mode.

14) RF OUTPUT (coarse). Stepped attenuator providing increments of 10 dB from 0 to 110 dB.

15) RF OUTPUT (fine). Continuously variable to interpolate between 10 dB steps of coarse attenuator.

16) RF OUTPUT connector. BNC 50 Ω. Output in -dBm given by the sum of coarse and fine RF OUTPUT control settings. Add +6 dB when CARRIER switch is in +6 dB position.

Rear panel - Fig. 2

4. 1) MAINS INPUT connector. Bulgin P580. The a.c. supply is connected through this plug which mates with the connector fitted to the supplied mains cable.

2) VOLTAGE SELECTOR switch. Selects either 95 to 132 V or 190 to 264 V to suit local a.c. supply.

3) AC FUSES (FS1 and FS3). Mains input fuses rated at 160 mA (time lag) for 190 to 264 V or 250 mA (time lag) for 95 to 132 V.

4) BATTERY FUSE (FS2). Battery input fuse rated at 500 mA (time lag).

5) BATTERY TERMINALS. Battery input terminals (negative is connected to chassis).

6) EXT MOD IN connector. BNC input for external modulation.

7) INT MOD OUT connector. BNC. 1 kHz internal modulation oscillator output when FUNCTION switch is set at INT AM or FM.

8) SYNC/SWEEP IN connector. BNC accepts a frequency sweep voltage or the control voltage from a digital synchronizer.

9) IF PROBE SUPPLY connector. DIN loudspeaker socket provides +22 V for external i.f. probe.

10) COUNTER OUT. BNC (or TNC) 50 Ω. For connection to an external counter or digital synchronizer.

Fig. 2 Rear panel connectors.

OPERATING PROCEDURE

Setting frequency

5. 1) Set SUPPLY switch at ON and check that the pilot lamp is lit.

2) Using the output cable supplied connect TF 2015A to the equipment under test.

Note ...

The reverse power protection circuit uses non-linear passive devices at the output terminal which start to conduct at a voltage above normal working levels and thus reflect reverse power from an effective short circuit. Two capacitors in the output circuit isolate from external low frequency and d.c. voltages up to ±50 V. RF fuse TM 9884 will still be necessary to protect any external matching unit if used in transceiver testing.

3) Set FUNCTION switch at CW and the CARRIER RANGE switch to select the desired frequency range.

4) Set CARRIER switch at ON and check that the meter pointer is within the white box.

5) Rotate the stepped TUNE control to position the pointer of the tuning scale as close as possible to the desired frequency. Then adjust the FINE TUNE control to position the pointer correctly. For final precise adjustment use the EXTRA FINE TUNE control.

Note ...

After thermal equilibrium has been reached the typical band switching restabilization time is 10 minutes.

CW output

6. For an unmodulated c.w. output.

1) Set FUNCTION switch at CW.

2) For normal operation set CARRIER switch at ON and check that the meter pointer is within the white box. For extra output set CARRIER switch at +6 dB (see para. 23).

3) Set RF OUTPUT controls as required.

Internal amplitude modulation

7. 1) Set FUNCTION switch at INT AM and CARRIER switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

2) Adjust SET MOD control to position the meter pointer at the centre of the white box.

3) Adjust AM DEPTH control to provide desired modulation. This control is direct reading with an accuracy which varies so that the true modulation depth may lie between 25% and 35% when 30% is indicated, or between 70% and 90% when 80% is indicated.

Internal frequency modulation

8. 1) Set FUNCTION switch at INT FM and CARRIER switch at ON. For extra output set CARRIER switch at +6 dB.

2) Adjust SET MOD control to position the meter pointer at the centre of the white box.

3) Adjust DEVIATION control to provide a deviation from 0 to 10 kHz (with multiplier at x1) or 0 to 100 kHz (with multiplier at x10).

External AM or FM

9. 1) Set FUNCTION switch to appropriate position i.e. : EXT AM or EXT FM and CARRIER switch at ON.

Note ...

External a.m. is not possible when CARRIER switch is at +6 dB.

2) Connect the external modulation source to EXT MOD IN (on rear panel); then adjust its level to position the meter pointer at the centre of the white box.

3) The desired modulation depth or deviation is then obtained by adjusting the relevant controls i.e. : AM DEPTH or DEVIATION.

Internal AM with external FM

10. 1) Set FUNCTION switch at INT AM and CARRIER switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

2) Adjust the SET MOD control to position the meter pointer at the centre of the white box.

3) Connect the external modulation source to EXT MOD IN (on rear panel).

4) Set FUNCTION switch at EXT FM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

5) Set FUNCTION switch at INT AM/EXT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

Internal FM with external AM

11. 1) Set FUNCTION switch at INT FM and CARRIER switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

2) Adjust the SET MOD control to position the meter pointer at the centre of the white box.

3) Connect the external modulation source to EXT MOD IN (rear panel).

4) Set FUNCTION switch at EXT AM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

5) Set FUNCTION switch at EXT AM/INT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

Internal modulation output

12. When FUNCTION switch is at INT AM, INT FM, INT AM/EXT FM, or EXT AM/INT FM, the 1 kHz modulating signal at a nominal 1 V (into a high impedance load), is available at the INT MOD OUT connector on rear panel. This signal may be used, for example, to trigger an oscilloscope at the modulating frequency or for a.f. tests.

ADDITIONAL INFORMATION

Operation with digital synchronizer

13. TF 2015A can be used with a digital synchronizer for a high degree of frequency stability. The synchronizer is driven from the COUNTER OUTPUT socket (rear of instrument) and its control voltage is applied to the SYNC/SWEEP connector.

Sweep facility

14. A voltage swing of 0 to +18 V applied to the SYNC/SWEEP IN connector will vary the carrier frequency over the frequency coverage of any one range. If a linear sweep is required, a suitable non-linear waveform must be used and to maintain the r.f. levelling accuracy, slow sweep speeds are necessary.

Attenuator calibration

15. The RF OUTPUT controls (coarse and fine attenuators) are calibrated in -dBm. Where e.m.f. or p.d. levels are to be used, reference should be made to the conversion scale on the

top of the instrument. The scale is as shown in Fig. 3.

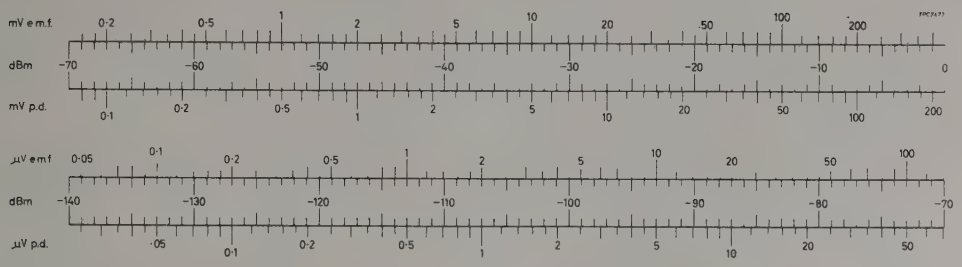

Fig. 3 Conversion scale : dBm to e.m.f. and p.d.

16. Alternatively, a conversion kit is available as an accessory (Part no. 31779-032Y) which, when fitted, enables the coarse and fine attenuator settings to indicate directly in μV and mV e.m.f.

Matching to high impedance loads

17. To match a load that is greater than 50 Ω to the output of TF 2015A a resistor R_S may be added in series with the generator output as in Fig. 4. The value of R_S is given by the difference between the load and the generator impedances, i.e.

$$R_S = R_L - R_O$$

in which case the voltage across the load, V_L, is given by

$$V_L = \frac{E}{2}$$

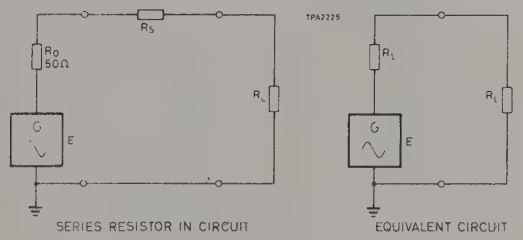

Fig. 4 High impedance matching.

18. The simple expedient of using a series resistor, may not produce sufficiently accurate matching for the representation of Fig. 4 to be a good enough approximation at all frequencies. More accurate matching can be obtained in a proper coaxial system by using the Matching Pad type TM 5573/3. When the 50 Ω input side of the pad is connected to the TF 2015A r.f. output, the output of the pad presents a 75 Ω source with an e.m.f. of $E/2$.

Use of i.f. probes

19. The i.f. probes generate crystal controlled signals at the customary receiver i.f.'s of 470 kHz and 10.7 MHz. They are powered from the 22 V IF PROBE plug on the generator. IF probes with other crystal frequencies can be supplied to special order.

20. The probes provide an auxiliary test signal for use in conjunction with the normal r.f. signal from the generator in receiver testing. In operation, the probe is positioned close to the receiver so that its signal is inductively coupled into the receiver i.f. circuit while the r.f. output from the generator is connected in the normal way to the receiver input.

21. This facilitates a number of receiver tests such as the following :

1) Checking receiver i.f. When the signal generator is tuned to the nominal frequency of a receiver channel, any difference between the receiver i.f. and the probe frequency will produce a beat note in the receiver output. Readjusting the signal generator for zero beat, using the EXTRA FINE TUNE control, ensures that the generator is correctly tuned to the r.f. circuits in the receiver.

2) Overriding receiver de-sensitization. It is often difficult to tune a signal generator to a receiver incorporating some forms of desensitization, such as squelch or a battery economizer, which respond to the presence of an i.f. signal. This is because the varying r.f. signal may traverse the receiver pass band too quickly, so that an i.f. signal is not present for long enough to sensitize the squelch or economizer circuit. By using the i.f. probe to inject an i.f. signal the receiver can be held in the sensitive condition while the r.f. generator is tuned into the pass band.

Quieting sensitivity measurements

22. 1) When making quieting sensitivity measurements on broadband equipments the carrier signal into the equipment under test can be removed by setting the CARRIER switch at OFF.

2) For narrowband equipments e.g. mobile transceivers, the following procedure is preferable :

a) Tune TF 2015A to the centre of the receiver pass band.

b) Using the TUNE switch detune TF 2015A and note the noise output level of the receiver.

c) Return the TUNE switch to its original position and then adjust the attenuator controls for the required quieting ratio - note the quieting sensitivity.

Correct use of +6 dB output facility

23. It should be noted that use of the +6 dB output facility is necessary only when c.w. outputs greater than 100 mV into 50 Ω are required e.g. : with the CARRIER switch at ON and the coarse and fine RF OUTPUT controls at 0 and 7 dB respectively, the output developed across a 50 Ω load will be 100 mV, or 50 mV when the fine control is reduced 6 dB to 13 dB. With the CARRIER switch at +6 dB and with the fine control at 13 dB the signal output level across 50 Ω then becomes 100 mV. Therefore, by adjusting the fine control from 13 dB to 7 dB the output level can be progressively increased from 100 mV to 200 mV (-7 dBm to -1 dBm).

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62

DECIBEL CONVERSION TABLE (continued)

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	**22**	12 59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	**28**	25 12	631 0
·03162	$1{\cdot}000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	**32**	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	**34**	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	**36**	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1\ 585 \times 10^{-4}$	**38**	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	**40**	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	**42**	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3\ 981 \times 10^{-5}$	**44**	158·5	$2\ 512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	**46**	199·5	$3{\cdot}981 \times 10^{4}$
$3\ 981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	**48**	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	**50**	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	**60**	1,000	$1{\cdot}000 \times 10^{6}$
$5{\cdot}623 \times 10^{-4}$	$3{\cdot}162 \times 10^{-7}$	**65**	$1{\cdot}778 \times 10^{3}$	$3{\cdot}162 \times 10^{6}$
$3{\cdot}162 \times 10^{-4}$	$1{\cdot}000 \times 10^{-7}$	**70**	$3{\cdot}162 \times 10^{3}$	$1{\cdot}000 \times 10^{7}$
$1{\cdot}778 \times 10^{-4}$	$3{\cdot}162 \times 10^{-8}$	**75**	$5{\cdot}623 \times 10^{3}$	$3{\cdot}162 \times 10^{7}$
$1{\cdot}000 \times 10^{-4}$	$1{\cdot}000 \times 10^{-8}$	**80**	$1{\cdot}000 \times 10^{4}$	$1{\cdot}000 \times 10^{8}$
$5{\cdot}623 \times 10^{-5}$	$3{\cdot}162 \times 10^{-9}$	**85**	$1{\cdot}778 \times 10^{4}$	$3{\cdot}162 \times 10^{8}$
$3{\cdot}162 \times 10^{-5}$	$1{\cdot}000 \times 10^{-9}$	**90**	$3{\cdot}162 \times 10^{4}$	$1{\cdot}000 \times 10^{9}$
$1{\cdot}000 \times 10^{-5}$	$1{\cdot}000 \times 10^{-10}$	**100**	$1{\cdot}000 \times 10^{5}$	$1{\cdot}000 \times 10^{10}$
$3{\cdot}162 \times 10^{-6}$	$1{\cdot}000 \times 10^{-11}$	**110**	$3{\cdot}162 \times 10^{5}$	$1{\cdot}000 \times 10^{11}$
$1{\cdot}000 \times 10^{-6}$	$1{\cdot}000 \times 10^{-12}$	**120**	$1{\cdot}000 \times 10^{6}$	$1{\cdot}000 \times 10^{12}$
$3{\cdot}162 \times 10^{-7}$	$1{\cdot}000 \times 10^{-13}$	**130**	$3\ 162 \times 10^{6}$	$1{\cdot}000 \times 10^{13}$
$1{\cdot}000 \times 10^{-7}$	$1{\cdot}000 \times 10^{-14}$	**140**	$1{\cdot}000 \times 10^{7}$	$1{\cdot}000 \times 10^{14}$

Chapter 4

TECHNICAL DESCRIPTION

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10 Circuit functions
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14 Tuning and frequency modulation
16 First a.l.c. loop
19 Pre-amplifier
21 Modulator and amplitude modulation
24 Counter amplifier
25 AM driver and d.c. offset circuits
28 Wide band amplifier
30 Second a.l.c. circuit
31 Fine r.f. output control
34 Modulation oscillator
37 Pre-distortion circuit
40 +6 dB output
42 Monitor circuits
45 Coarse r.f. output control
46 Reverse power protection
49 Power unit
50 Supply filters

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INTRODUCTION

1. This chapter, which outlines the overall and circuit functions of TF 2015A, is intended to be read with reference to the circuit diagrams and illustrations contained within this manual.

2. All printed circuit boards and sub-assemblies in the instrument are allocated a unit identification number in the sequence A0 to A12 and A16 to A23 and where practical the assembly is marked with this number. The main sub-assembly layout is shown in Chap. 4.

3. Construction consists of front and rear panels supported by side frames which also carry an r.f. box. The r.f. box contains eleven separate oscillator circuits A1 to A11 mounted on a mother board A12 which is hinged to allow access to the associated components. The box also contains a screened compartment A16 containing the r.f. amplifier, modulator and counter

amplifier circuits. The automatic level control (a.l.c.) circuits A17 are mounted on top of this compartment. The low r.f. leakage lid is retained by four fixing screws. The underside of the r.f. box carries the filter box and units A18, A19 and A20.

4. Units A21 and A23 are mounted on one of the side frames and the opposite frame carries the mains transformer. Inputs and outputs are conveyed through BNC connectors and terminals located on the front panel and at the rear of the instrument.

CIRCUIT SUMMARY

Block diagram - Fig. 1

5. A separate voltage tuned oscillator is used for each of the eleven ranges. Output from the selected oscillator, which is maintained at a constant level by the first automatic level control (a.l.c.) loop, is applied to a pre-amplifier. The frequency of each oscillator is controlled by means of a pair of varactor diodes across the tuned circuit. The capacitance of the diodes, and hence the resonant frequency of the tuned circuit, is determined by the control voltage applied to the diodes. This arrangement provides for both tuning and frequency modulation, a variable d.c. control voltage being applied for tuning purposes and an a.f. modulating signal for f.m.

6. Output from the pre-amplifier is applied to a modulator and at a suitable level to a counter amplifier. The r.f. output from the modulator which is approximately 30 mV is passed to a wide band amplifier incorporating an inter-stage current controlled attenuator. Output from the amplifier is applied to the input of the coarse attenuator (coarse r.f. output control) and through a detector circuit to a second a.l.c. loop which, operating in conjunction with the fine attenuator (fine r.f. output control) sets and then maintains the level of the r.f. input to the coarse attenuator. In c.w. operation a meter indicates correct operation of the a.l.c. circuits. In the modulated modes it monitors the a.f. reference level.

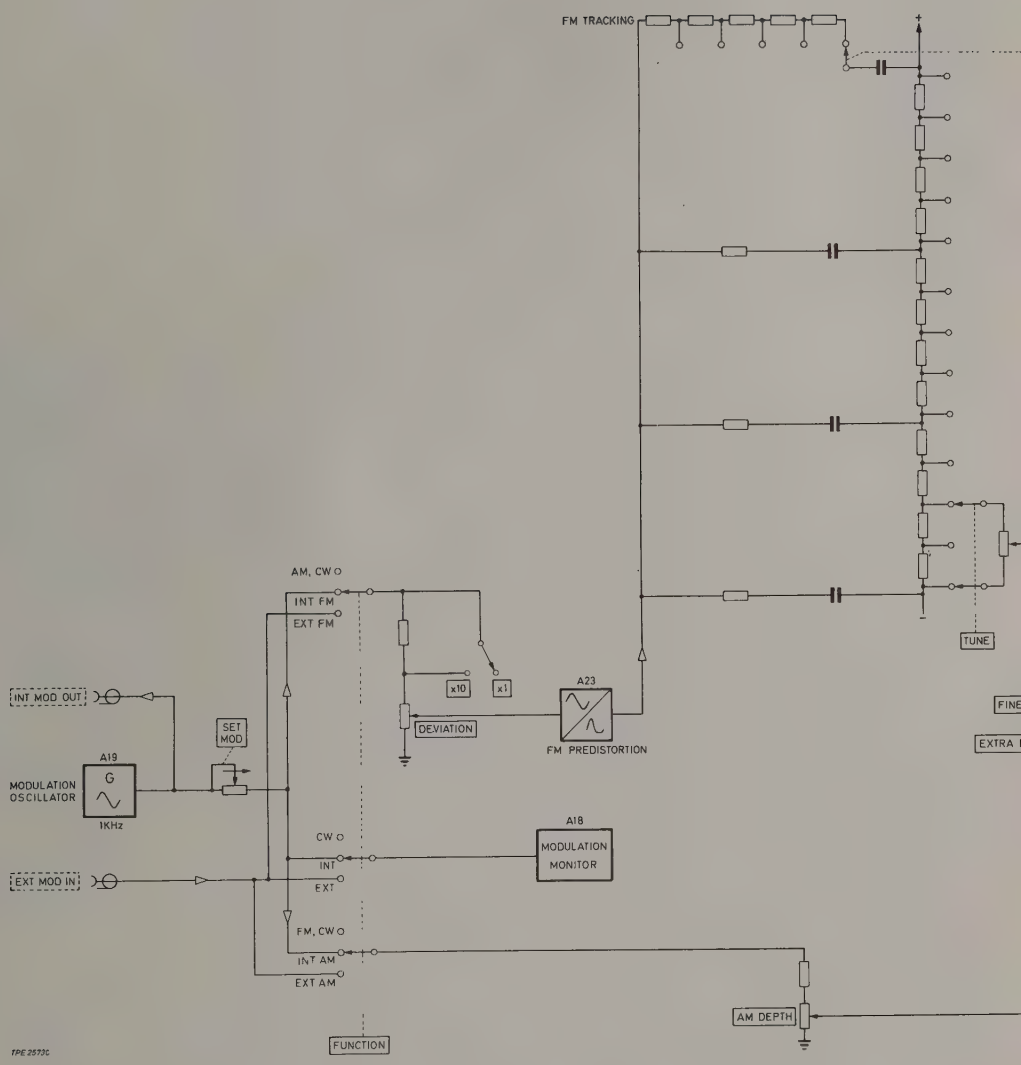
7. The r.f. carrier can be amplitude or frequency modulated using either the internal modulation oscillator or an external signal. For a.m. the a.f. signal is applied to the modulator through a push-pull driver circuit and for f.m. to the tuning circuits. To ensure that deviation is maintained acceptably constant over each frequency range and to minimize distortion, tracking and pre-distortion circuits are employed.

8. A Wien bridge oscillator operating at a frequency of 1 kHz is used for internal modulation and to provide an a.f. output. For both a.m. and f.m. the internal a.f. signal is routed through the SET MOD control which is adjusted to obtain a modulation reference level. The desired a.m. depth or f.m. deviation is then obtained by adjustment of the appropriately indicated controls.

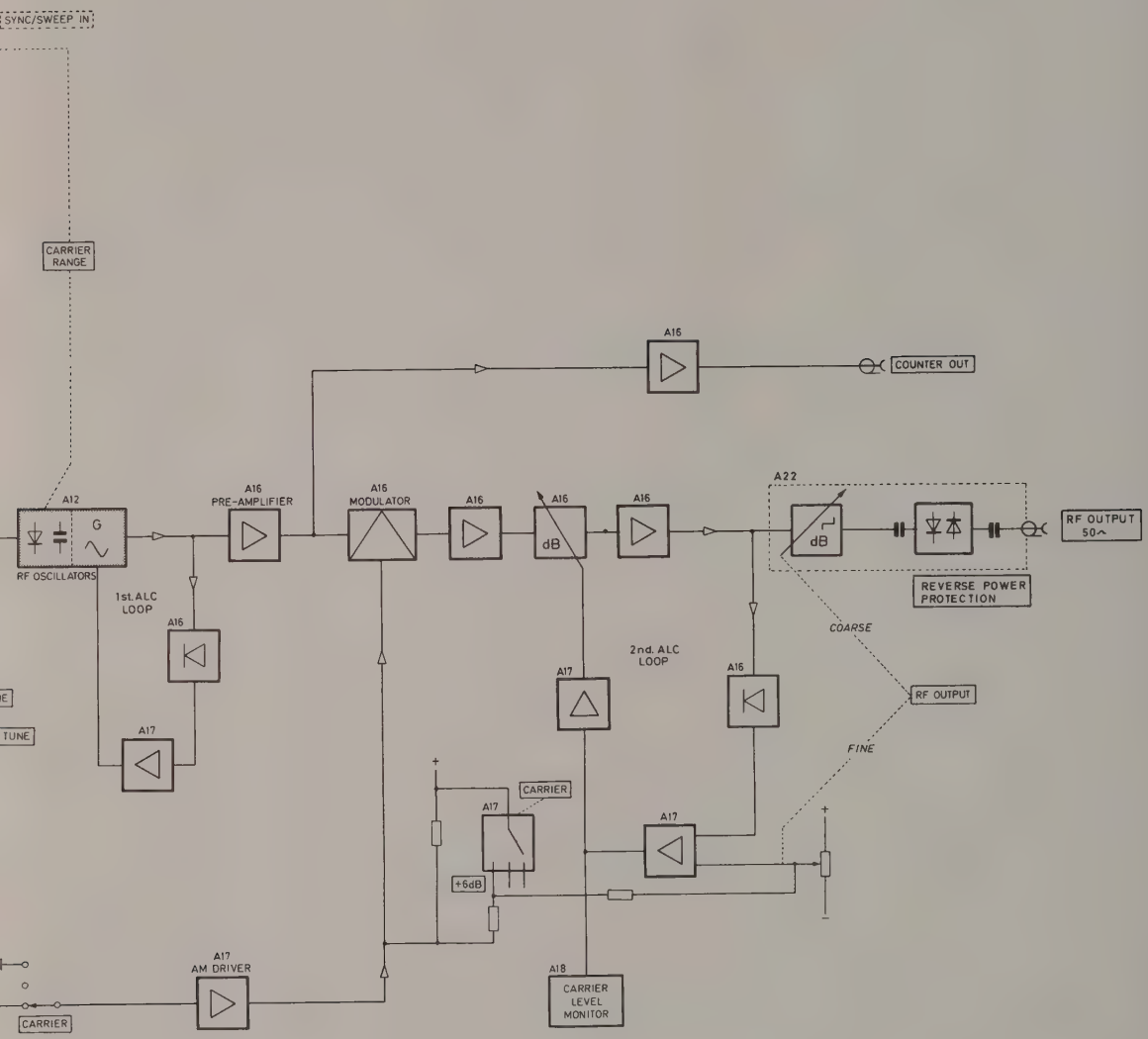
9. Inputs are provided for connection of an external modulating signal and for application of a suitable sweep waveform. A 22 V d.c. output is available as a supply for certain associated equipments, e.g. i.f. probes, and an output is provided for connection to a frequency counter.

CIRCUIT FUNCTIONS

10. Block schematic diagram Fig. 1 inter-relates the various circuits employed in TF 2015A whilst the paragraphs which follow explain the functions of each.


FM TRACKING
AM, CW
INT FM
EXT FM
x10
x1
DEVIATION
A23
FM PREDISTORTION
TUNE
FINE
EXTRA
INT MOD OUT
SET MOD
A19
MODULATION OSCILLATOR
G
1KHz
CW
INT
EXT
EXT MOD IN
A18
MODULATION MONITOR
FM, CW
INT AM
EXT AM
AM DEPTH
FUNCTION
TPE 2573C

Block


SYNC/SWEEP IN
CARRIER RANGE
A15
COUNTER OUT
A22
A12
G
RF OSCILLATORS
A16 PRE-AMPLIFIER
A16 MODULATOR
A16
A16
dB
A16
dB
RF OUTPUT 50Ω
REVERSE POWER PROTECTION
1st ALC LOOP
A16
A17
2nd. ALC LOOP
A17
A16
COARSE
RF OUTPUT
FINE
TUNE
CARRIER
A17
A17
+6dB
A17 AM DRIVER
A18 CARRIER LEVEL MONITOR
CARRIER

agram.

RF oscillators
Circuit diagram Chap. 7, Fig. 2, Unit A12 (sub-assemblies A1 to A11)

11. All the oscillators use a modified Hartley circuit and differ only in the value of components. Oscillators A1 to A9 employ a field effect transistor. A10 and A11 use bipolar transistors. Feedback is established by inductive coupling between the two sections of the primary winding of transformer T1.

12. Frequency is determined by varactor diodes D1 and D2 operating as variable capacitors to tune the primary winding of T1. The capacitance values of D1 and D2 are varied by application of d.c. voltages set by the tuning circuit A21. For ranges 1 to 9, trimmer capacitor C4 is adjusted to correctly set the high frequency end of the range with the core of T1 adjusted at the low frequency end. On ranges 10 and 11 only C4 is adjustable.

13. The oscillators are individually activated by switched application of the d.c. supply whilst output from the selected oscillator is obtained from the secondary winding of T1 through the appropriate steering diode, D1 to D11. Diode D12 is incorporated to reduce the effective capacitance of D1 to D7 which could influence the frequency coverage of ranges 8 to 11.

Tuning and frequency modulation
Circuit diagram Chap. 7, Fig. 1, Units A19 and A21

14. Because of the non-linear relationship between varactor voltage and capacitance, a 19-position switch with a chain of selected resistors is used to provide a stepped linear change of frequency. Potentiometer A0R38 interpolates between switch positions. The additional potentiometer A0R37 enables TF 2015A to be precisely tuned to a receiver under test.

15. For a frequency modulated output the a.f. signal is routed to the varactors through the f.m. controls, tracking resistors A0, R5 to R15, the pre-distortion circuit A23, amplifier TR3, TR4, TR5 and the tuning control circuits. The tracking resistors are automatically selected by the range selector switch to maintain equal deviation over each frequency range. A21 TR1 is used as a low impedance source for the f.m. drive.

First a.l.c. loop
Circuit diagram Chap. 7, Fig. 3, Units A16 and A17

16. Output from the selected oscillator is maintained at a nominal level of 50 mV by the first automatic level control (a.l.c.) loop. The oscillator output is applied to a detector circuit, D1 and D2, which is referenced by the set voltage at the junction of R1 and R2 on A17.

17. Output from the detector is applied to one input of a differential pair, TR1 and TR2, where it is compared with a reference level preset by network R4, R5, R6 and R7. Any difference in the level of the signals either towards positive or negative appropriately varies the bias to TR3 which then varies the current in the f.e.t. in the selected oscillator to re-establish the required output level.

18. Diodes A17D1 and D2 compensate for the temperature changes of the detector diodes, A16D1 and D2. Capacitors A17, C2 and C11 are incorporated to minimize spurious f.m. which could be produced by a.l.c. circuit noise.

Pre-amplifier
Circuit diagram Chap. 7, Fig. 3, Unit A16

19. The controlled output level from the selected oscillator is applied to a wide band pre-amplifier providing a gain of approximately 12 dB, i.e. a nominal output of 200 mV.

20. The circuit consists of four stages, TR1, TR2, TR3 and TR4, and employs both common base and common emitter configurations. The common base circuits and screens mounted on the printed circuit board are incorporated to provide the required inter-stage isolation.

Modulator and amplitude modulation
Circuit diagram Chap. 7, Fig. 3, Unit A16

21. The circuit configuration is basically that of a single balanced bridge modulator employing pin diodes operating as variable (current controlled) r.f. resistors to achieve minimum r.f carrier distortion.

22. Initially, with no d.c. or a.f. inputs, the two inputs from T1 are 180^{o} out of phase and, since R17 and R18 are equal, the bias currents and consequently the resistances of the diodes are equal. With these conditions the bridge is balanced so no signal is present at T2.

23. To provide a constant r.f. output for c.w., d.c. offsets from circuits A17TR7 and TR8 are applied to partially unbalance the bridge. For amplitude modulation the a.f. signal from the push-pull driver circuit A17TR4, TR5 and TR6 is applied to the bridge modulator. The a.f. signal produces offset levels proportional to its amplitude so the bridge becomes progressively unbalanced to an extent which is greater or less during each positive and negative half cycle of the a.f. waveform.

Counter amplifier
Circuit diagram Chap. 7, Fig. 3, Unit A16

24. Part of the r.f. signal voltage at the output of the pre-amplifier is applied to a common emitter amplifier, TR6, which serves to drive an external frequency counter. Output at the COUNTER OUT connector is nominally 100 mV into 50 Ω.

AM driver and d.c. offset circuits
Circuit diagram Chap. 7, Fig. 3, Unit A17

25. The two circuits TR7 and TR8 operate to set the level of the d.c. offsets applied to the modulator and consequently the r.f. level to A16TR5.

26. With the CARRIER switch at ON (normal r.f. output) TR7 and TR8 are non-conducting so the d.c. offset levels to the modulator are determined by R23 and R24. When the CARRIER switch is at +6 dB TR7 and TR8 are switched on to connect R25 and R26 in parallel with R23 and R24 to further unbalance the modulator, reducing its insertion loss by approximately 8 dB. Diode D3 is incorporated to prevent current flowing in R26 when TR7 and TR8 are in the off condition.

27. The a.m. driver serving the modulator consists of a push-pull a.f. amplifier, TR4 and TR6, which applies offset levels proportional to the varying amplitude of the a.f. cycle to produce an amplitude modulated output as explained in para. 23. TR5 maintains the amplifier current constant during the a.f. cycle.

Wide band amplifier
Circuit diagram Chap. 7, Fig. 3, Unit A16

28. This consists of three common emitter stages TR5, TR7 and TR8 with an interstage current controlled variable attenuator. This operates in conjunction with the second a.l.c. loop and fine r.f. output control to set and maintain constant the signal level at the input to the coarse r.f. output attenuator unit A22.

29. The attenuator which controls the gain of the amplifier employs pin diodes D7 and D8 as current controlled variable resistors, their resistance being determined by bias levels controlled by A17TR9 and TR10.

Second a.l.c. circuit
Circuit diagram Chap. 7, Fig. 3, Unit A17

30. The signal level at the output of the wide band amplifier is detected by diodes D9 and D10 and then passed to A17IC1 where it is compared with a level dictated by the setting of the fine r.f. output control, A0R16. Any difference in level between the two applied signals causes the output of IC1 to change. This changes the currents through TR9 and TR10 which controls the resistance of the variable attenuator diodes, D7 and D8, and establishes the required input to the coarse r.f. output control.

Fine r.f. output control
Circuit diagram Chap. 7, Figs. 1 and 3, Units A16, A17, A18

31. The calibration accuracy of the fine r.f. output control is primarily dependent upon correct performance of the second a.l.c. loop incorporating circuits A18TR2, the a.l.c. amplifier A17, the interstage attenuator circuit A16D7 and D8 and the detector circuit A16D9 and D10.

32. The circuit A18TR2 provides a fixed reference voltage to the detector D9 and D10 to produce a voltage level at A17IC1 pin 2 which is determined by the difference between the reference voltage and the detected r.f. voltage. It also provides a preset voltage to A17IC1 pin 3 at a level which is dictated by the setting of the fine r.f. output control A0R16. Output from IC1 pin 6, which depends on the voltage levels at pins 2 and 3, controls the current through the differential pair TR9 and TR10 such that the resistances of D7 and D8 in the interstage attenuator are set to establish the required amplifier gain and therefore the desired r.f. output level.

33. When the fine attenuator control A0R16 is adjusted for a different r.f. output, the voltage levels at IC1 pins 2 and 3 will momentarily be unequal, which causes the output at IC1 pin 6 to change and consequently the current through TR9 and TR10. The increased or decreased current sets the attenuator D7 and D8 to appropriately vary the gain of the wide band amplifier to re-establish equal voltage levels at IC1 pins 2 and 3 and a higher or lower signal level to the input of A22.

Modulation oscillator
Circuit diagram Chap. 7, Fig. 1, Unit A19

34. A Wien bridge circuit operating at a frequency of 1 kHz is employed for internal modulation of the r.f. signal and to provide an a.f. output at the INT MOD OUT connector.

35. The input of TR1 is connected across the shunt arm R2, C1, of the bridge and its output is passed to the amplifier circuit TR2. The oscillator output signal is across R8 and is applied to the series arm of the bridge C2, R6, to obtain positive feedback. During the non-oscillating condition prior to 'switch on' the amplifier gain is high. At 'switch on' oscillation commences readily, causing the resistance of thermistor R7 to fall and the amplifier gain to stabilize at a value just sufficient to maintain oscillation.

36. For amplitude modulation the a.f. signal is routed through the SET MOD control and AM DEPTH control to the a.m. driver circuit A17. For frequency modulation the a.f. signal is applied through the SET MOD control and DEVIATION control to the switched f.m. tracking resistors A0R5 to R15 (ganged to carrier range selector switch). The signal is then routed via the predistortion circuits A23 and f.m. driver A19 TR3, TR4, TR5 to the tuning circuits A21. A source follower amplifier A18TR3 buffers the a.f. signal from changes in load caused

by operation of the DEVIATION switch.

Predistortion circuit
Circuit diagram Chap. 7, Fig. 1, Unit A23

37. This circuit minimizes f.m. distortion by predistorting the a.f. waveform to compensate for the capacitance/voltage characteristic of the varactors. The circuit is designed to expand the positive half of the a.f. waveform and compress the negative half.

38. Circuit performance is largely dependent upon the attenuator R2 and R3 which is set by the shunt diodes D1 and D2. During the positive half of the a.f. waveform D1 is caused to conduct by the positive signal level at A21 pin 13 and since D1 is effectively in parallel with R2 the insertion loss of the attenuator is reduced to increase the amplitude of the positive half of the waveform to the f.m. driver. During the negative half of the waveform D2 is caused to conduct, effectively reducing the value of R3 and limiting the waveform excursion.

39. The circuit consisting of R7 to R11 reduces frequency drift by appropriately varying the d.c. supply to the tuning network R17 to R36 to compensate for temperature rise within the instrument.

+6 dB output
Circuit diagram Chap. 7, Figs. 1 & 3, Units A16, A17, A18

40. When the CARRIER switch is at +6 dB the levels of the d.c. offsets to the modulator A16 are increased to reduce its insertion loss (see para. 26). Resistor R25 in the circuit A18TR2 is connected (through D6) in parallel with R24 to increase the current through the network R22, R23 and A0R16 and consequently the set voltage output from A0R16 to IC1 pin 3. The a.l.c. loop then operates to increase the r.f. output by 6 dB.

41. With the CARRIER switch at +6 dB amplitude modulation is not possible and is prevented by connection of the a.m. drive line to earth.

Monitor circuits
Circuit diagram Chap. 7, Fig. 1, Unit A18

42. When the FUNCTION selector is set for a.m. or f.m. modulation the output from the internal or external oscillator is routed to the monitor circuit A18TR1.

43. The a.f. is rectified by the circuit D1 and D2 and the positive d.c. output is applied to the meter ME1 through the emitter follower TR1 and diode D3. To obtain the desired sensitivity the meter is backed off by a set d.c. level from the network R10, R11 and R12 and by preset adjustment of R5 which sets a reference level to the detector circuit D1 and D2. Thermistor R9 provides the necessary temperature compensation to the network R10, R11 and R12 while D3 prevents the application of reverse currents to TR1.

44. Since the calibration accuracy of the fine r.f. control is largely dependent upon the performance of the a.l.c. loop A17, the meter (when the FUNCTION selector is set at CW) serves only to indicate correct operation of the a.l.c. loop. The circuit R12 to R16 with R18 and R19 forms a limits bridge with R17 preset to position the pointer of the meter at the centre of the white box on the meter scale. Provided the output from A17IC1 pin 6 remains within certain limits, diodes D4 and D5 are non-conducting. Incorrect operation of the a.l.c., which could be caused by malfunction of the preceding r.f. circuits, produces an output from IC1 which will be above or below the expected limits. The appropriate diode then conducts causing the bridge condition to change so that the meter pointer will be positioned at zero or f.s.d.

Coarse r.f. output control
Circuit diagram Chap. 7, Fig. 3, Unit A22

45. This provides a loss of 110 dB in steps of 10 dB. The pad sections consist of resistive networks with a characteristic impedance of 50 Ω. The unit is divided into compartments to ensure maximum shielding between pads. Pads are connected into circuit by microswitches housed in screened compartments and operated in pairs by leaf springs actuated by cams on the control spindle.

Reverse power protection

46. D1 is a passive protection device consisting of a pair of shunt PIN/NIP diodes packaged on a stud heat sink and housed in the output compartment of the coarse attenuator.

47. Up to the maximum generator levels, D1 does not conduct but behaves as a small shunt capacitance. At increased signal levels, there is a build-up of stored charge in the Intrinsic or I-region of the PIN/NIP diodes, lowering their resistivity. Above the threshold level the resistivity of the diodes falls sharply to a very small value so that most incident power is reflected. At an incident power level of 25 W, the power leaking past the protection is less than 0.75 W.

48. Capacitors C1 and C2 isolate the diodes and the input from external low frequency and d.c. voltages up to a maximum of ±50 V.

Power unit
Circuit diagram Chap. 7, Fig. 1, Unit A20

49. The power unit, which operates by switch selection from a.c. supplies of 95 to 132 V or 190 to 264 V, 45 to 500 Hz, consists basically of mains transformer A0T1, a full wave rectifier circuit A20D1, D2, D3 and D4 and a conventional voltage regulator circuit. The +22 V output from the regulator supplies all the circuits except the frequency control sections which are supplied from a second sub-stabilizer which provides +19 V. The 19 V regulator sampling lines maintain the voltage across the tuning network. TR6, R9 and R10 provide a low noise voltage reference for the sub-stabilized supply.

Supply filters

50. Filters are incorporated in supply lines to various units to ensure that spurious r.f. signals are not introduced into the circuits. All the filters are contained in a separately screened box which consists of two screen divided sections. Each filter employs two series connected chokes and lead-through type shunt capacitors.

Chapter 5

MAINTENANCE

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6 Units A18, A19, A20, A21, A23
7 Supply filters
8 Unit A22
9 Preliminary checks
10 Performance checks
11 Test equipment
12 Power supply unit A20
13 Frequency calibration unit A12
14 RF output (normal)
15 RF output (+6 dB)
16 Checking v.s.w.r. (frequencies 350 to 500 MHz)
17 Checking v.s.w.r. (frequency 10 to 350 MHz)
18 Modulation oscillator performance
19 Checking f.m. deviation
20 Checking a.m. depth
21 Checking f.m. tracking
22 Checking a.l.c. system
23 Counter output level
24 External modulation sensitivity
25 AM distortion
26 FM distortion
27 Spurious f.m. on c.w.
28 Spurious a.m. on c.w.
29 Spurious a.m. on f.m.
30 Spurious f.m. on a.m.
31 Carrier harmonics
32 Coarse r.f. output control
33 Reverse power protection
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INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order, checking overall performance and to assist in tracing a fault to the particular part of the suspect circuit. Before attempting any maintenance on the equipment you are advised to read the preceding Technical Description chapter.

ACCESS TO SUB-ASSEMBLIES AND COMPONENTS

Screw fasteners

2. The majority of screw threads used in the instrument are metric of various sizes but in some positions BA threads are used. All chromium plated screws and all screws tinted blue are metric. Ensure that screws removed are re-fitted in original positions.

Removal of case

3. The case is in two sections. Remove the six screws at the rear of the instrument and then slide off top and bottom sections.

Sub-assemblies A1 to A12

4. A1 to A11 are r.f. oscillator assemblies mounted on a mother board, A12, which is contained within the r.f. box. To obtain access remove the cover of the r.f. box by removing the four fixing screws. Unit A12 is hinged to provide access to the oscillator assemblies as shown in Fig. 1. The component layout for each assembly is as shown in Fig. 2.

Units A16 and A17

5. The position of these units is shown in Figs. 1 and 2. Access to A16 is obtained by removing the four screws holding the screening plate and then by carefully folding this back with A17 attached. A17 is directly accessible.

Units A18, A19, A20, A21, A23

6. The position of these units is shown in Fig. 2 and all are directly accessible from the underside of the instrument.

Supply filters

7. These are contained in a separately screened compartment. Inputs and outputs can be accessed through the associated capacitors which are accessible by carefully lifting A18 upwards and folding A12 back as shown in Fig. 1.

Unit A22

8. To remove the attenuator, carefully disconnect the two semi-rigid coaxial cables, remove the control knob and nut holding the unit to the panel, remove the bracket screw then lift the unit from the chassis.

PRELIMINARY CHECKS

9. (1) Check to ensure that all switches are undamaged and operating correctly and verify that connectors are securely mated.

(2) Check that fuses are of the correct rating and type, and fit correctly in the holders.

PERFORMANCE CHECKS

10. Many of the methods in this section are simplified and of restricted range compared with those which would be needed to demonstrate complete compliance with the specification. They

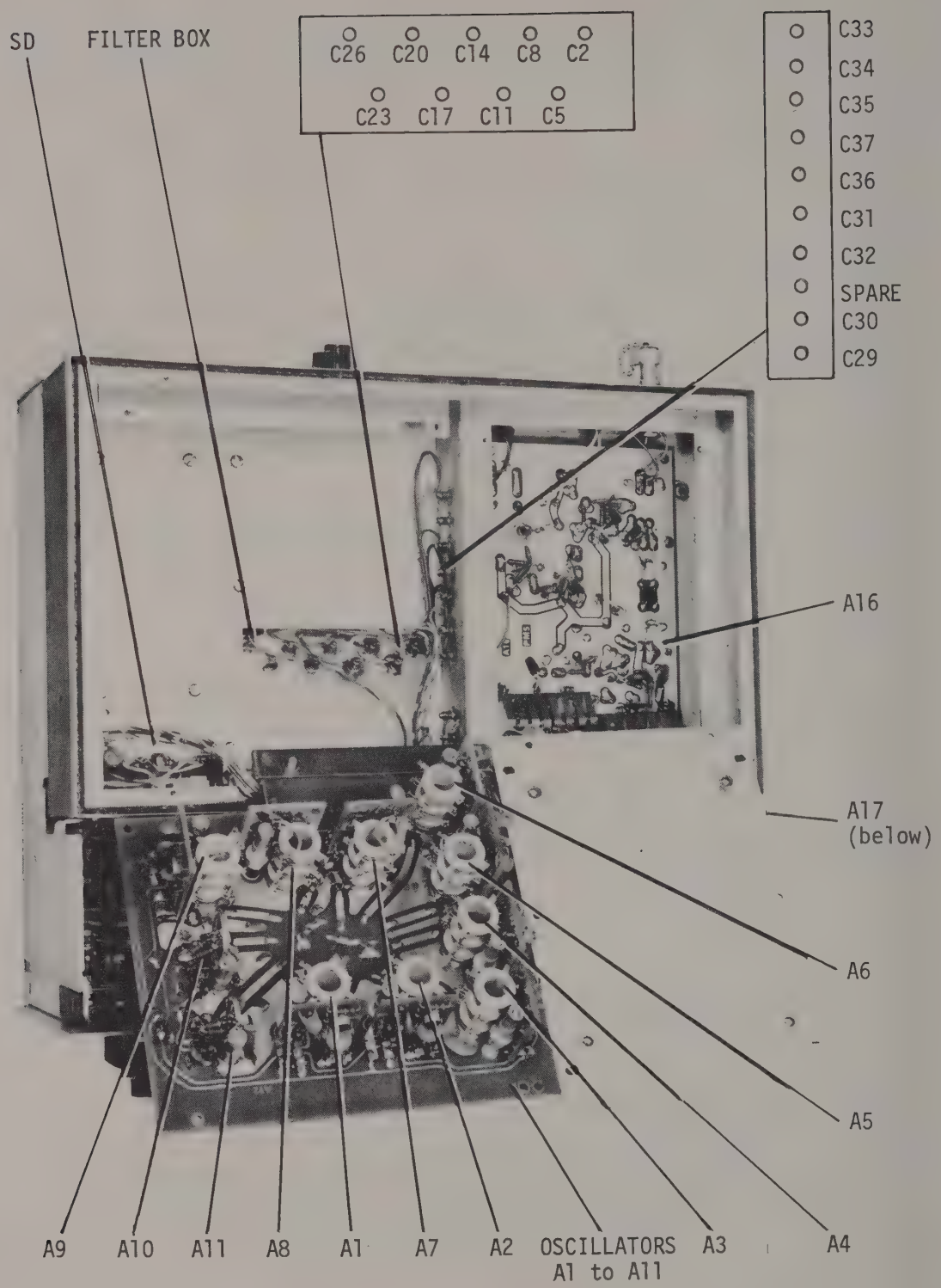
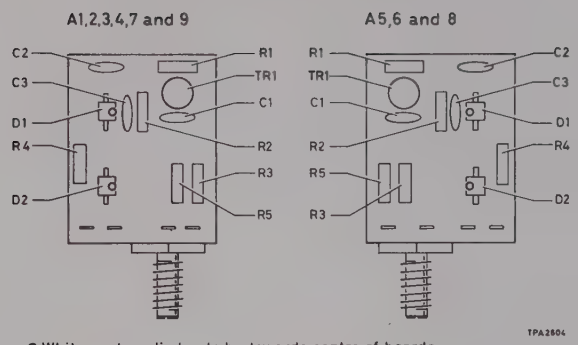
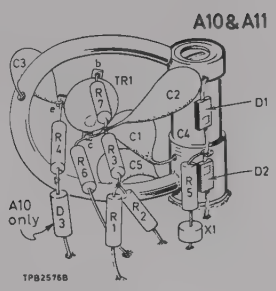


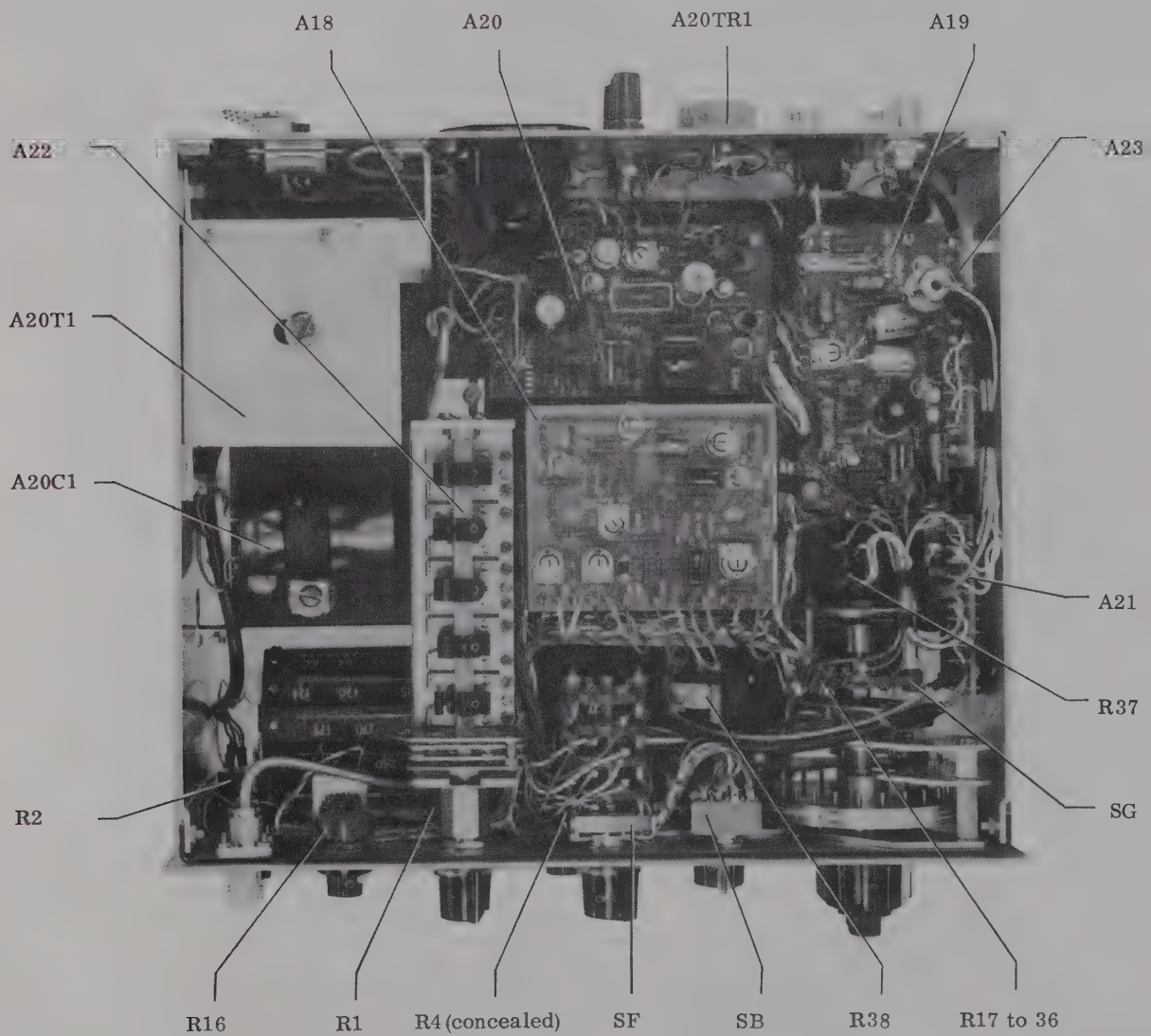
Fig. 1 Component layout, instrument top view with boards A12 and A17 hinged back.



O White spot on diodes to be towards centre of boards.

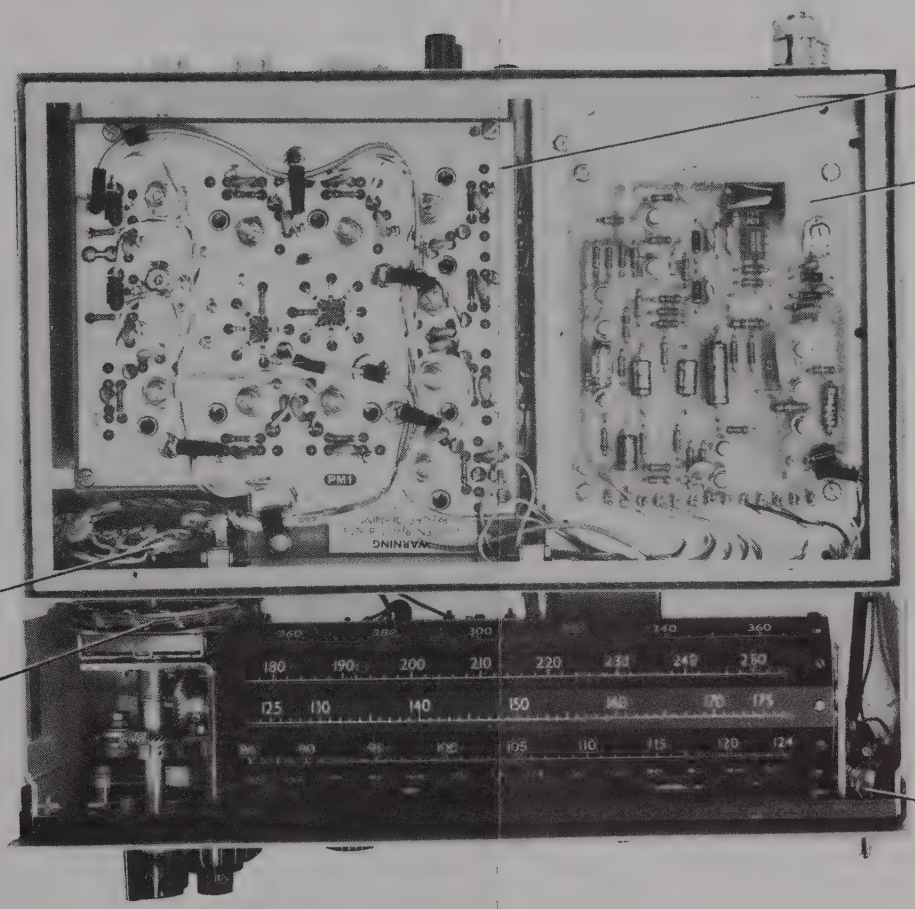


Layout of oscillator assemblies



Bottom view

Component layout,



Top view

crument and oscillator assemblies

should be regarded only as providing a check procedure, for use during routine maintenance, to determine whether adjustment or repair is necessary. Any figures given are for guidance only and should not be taken as guaranteed performance figures unless they are quoted in the Performance Data in Chap. 1.

Test equipment

11. The test equipment required for maintenance and repair of the instrument is listed in Table 1.

Note ...

When making tests to verify that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.

TABLE 1 TEST EQUIPMENT

Item	Description	Recommended model
a	560 MHz counter	2432A
b	10 MHz 50 Ω signal source, minimum e.m.f. 2 V	TF 2016A
c	'N' type 50 Ω load	TM 7967
d	Digital voltmeter, up to 50 V with resolution of 1%	
e	30 MHz oscilloscope	
f	Wave analyser	TF 2330A
g	RF millivoltmeter	TF 2603
h	'T' connector	TM 7948
i	RF milliwattmeter	Type 6460
j	22 cm air spaced line	General Radio type 874-LO
k	DC microvoltmeter	
l	Distortion factor meter	TF 2331A
m	AM/FM modulation meter	TF 2300B
n	AF oscillator, 2 V output	
o	Psophometer	Hatfield Instruments type MBC 1000
p	RF detector	TM 9650/1
q	Short circuit current monitor	See Fig. 3
r	Spectrum analyser	Hewlett Packard type 8554B/8552A/140T
s	Multimeter	GEC Selectest
t	Variable voltage transformer	Variac
u	AC valve voltmeter	TF 2600B

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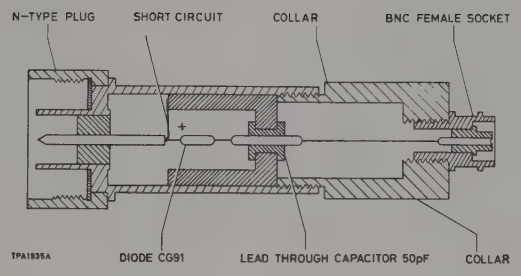

Fig. 3 Short circuit load.

Power supply unit A20

Test equipment : items d, f, t.

12. (1) With TF 2015A connected to the a.c. supply and switched on, connect the digital voltmeter between tag 17 (positive) and tag 15 (negative) and check that the meter indicates 22 V ±100 mV. If necessary adjust R4 to obtain this requirement.

(2) Connect the digital voltmeter between tag 12 (positive) and tag 15 (negative) and check that the meter indicates 19 V ±100 mV. If necessary, select values for R14 and R17 to obtain this requirement.

(3) Apply the a.c. input through a variable voltage transformer and check, using the digital voltmeter, that with inputs to the power supply of between 190 and 260 V the voltage between tag 12 and tag 15 is maintained to within ±40 mV of that obtained in (2).

(4) Disconnect the a.c. supply and connect a 24 V d.c. supply to the battery terminals and check that the 19 V output at tag 12 is within ±100 mV.

(5) Disconnect the d.c. supply and re-connect TF 2015A directly to the a.c. supply.

Frequency calibration unit A12 (sub-assemblies A1 to A11)

Test equipment : item a.

13. (1) Set the FUNCTION selector at CW and CARRIER switch at ON then ensure that the pointer of the MOD/CARRIER meter is within the white box on the meter scale.

(2) Connect the counter to the COUNTER OUT socket (rear of instrument). Set the CARRIER RANGE selector in turn to ranges 1 to 11 and check, using the TUNE, FINE TUNE and EXTRA FINE TUNE controls, that the scale calibrations at three points on each range i.e. low and high frequency ends and at a centre frequency are within ±1.5% of counter indication.

(3) If necessary, for range 1 to 9 inclusive adjust the appropriate core of T1 for low frequency correction and the appropriate capacitor C4 for high frequency correction. Since the core and C4 are interdependent ensure that after the second adjustment the first adjustment remains correct. For ranges 10 or 11 only C4 can be adjusted for high frequency correction. The oscillators are positioned as shown in Fig. 1.

RF output (normal)

Test equipment : item i.

14. (1) With the FUNCTION selector and CARRIER switch set as in para. 13 (1) connect the power meter to the output of TF 2015A.

(2) Set the RF OUTPUT controls at 0 and 7 dB.

(3) Verify that the pointer of the MOD/CARRIER LEVEL meter is within the white box. Using the TUNE control to step through each frequency range, verify that the output level is held at -7 dBm ±1 dB up to 100 MHz and within ±2 dB from 100 MHz to 520 MHz.

(4) Ensure that when making each check the pointer of the MOD/CARRIER meter remains within the white box.

RF output (+6 dB)

Test equipment : item i.

15. (1) With the FUNCTION selector, CARRIER switch, RF OUTPUT controls, set as in para. 13 and with the power meter connected to the RF OUTPUT socket set the frequency of TF 2015A at 100 MHz. Note the indicated output then set the CARRIER switch at +6 dB and check that the output level has been increased by 6 dB ±1 dB.

(2) Repeat the check with TF 2015A tuned to 500 MHz and check that with the CARRIER switch at +6 dB the output level has been increased by 6 dB ±1 dB.

Checking v.s.w.r. (frequencies 350 to 500 MHz)

Test equipment : items j, k, q.

16. (1) Connect the test equipment as in Fig. 4.

(2) Set the FUNCTION selector at CW, the CARRIER switch at +6 dB, the RF OUTPUT controls at -17 dBm (coarse control at 10 dB fine control at 7 dB) and the output frequency at 500 MHz.

(3) Ensure that the pointer of the MOD/CARRIER meter is within the white box.

(4) Set the adjustable line to $\frac{1}{2}.\lambda$ (half wavelength) of the signal by applying the formula :

$$\lambda = \frac{300}{f}$$

where λ = wavelength in metres

and f = frequency in MHz.

(5) Adjust the line length for a maximum indication on the microvoltmeter and note its reading. Adjust the line length for minimum indication on the microvoltmeter, at $\frac{1}{4}$ wavelength away from the maximum response. Again note the voltmeter reading.

(6) At any one frequency, the voltage detected across the residual elements of the short circuit will be a measure of the current flowing into it. As the short circuit is moved through $\lambda/4$, the current re-reflected by the TF 2015A source will first add to and then subtract from the incident current in the short. The ratio of the two currents therefore is a measure of the source v.s.w.r. The diode operates in the square low region and so, to obtain the required quantity from the microvoltmeter readings e_{max} and e_{min}, the square root of the ratio is required, giving

the following formula :

$$\text{v.s.w.r.} = \sqrt{\frac{e\ max}{e\ min}}$$

The v.s.w.r. should be less than 1.3.

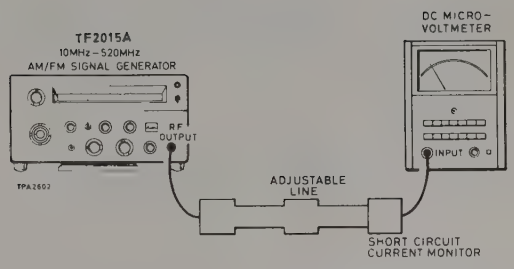

Fig. 4 Test gear arrangement to check v.s.w.r.

Checking v.s.w.r. (frequencies 10 to 350 MHz)

Test equipment : items c, g, h.

17. (1) With the TF 2015A controls set as in para. 13 connect the voltmeter to the RF OUTPUT of TF 2015A using the T connector and note the indicated output level.

(2) Connect the 50 Ω load to the T connector and again note the indicated output level.

(3) Compute the impedance Z using the following formula :

$$Z = \frac{50E}{V} - 50$$

where E = the open circuit output level
and V = the output across the 50 Ω load.

From the above,

$$\text{v.s.w.r.} = \frac{Z}{50}$$

The v.s.w.r. should be less than 1.3.

Modulation oscillator performance

Test equipment : items a, l.

18. (1) Set the FUNCTION selector at INT MOD and the CARRIER switch at OFF.

(2) Connect the counter to the INT MOD OUT socket (rear of instrument) and check that the indicated frequency is between 920 Hz and 1080 Hz.

(3) Disconnect the counter and connect the distortion factor meter (d.f.m.) to the INT MOD OUT socket. The measured distortion should not be greater than 0.25%.

(4) Set the d.f.m. at high input impedance to measure voltage and check that the measured voltage is greater than 1.5 V r.m.s.

Checking f.m. deviation

Test equipment : item m.

19. (1) Set the FUNCTION switch at INT FM, set the CARRIER switch at ON, set the frequency of TF 2015A at 20 MHz then adjust SET MOD control to position the pointer of MOD/CARRIER meter at centre of white box on meter scale.

(2) Connect the modulation meter tuned to 20 MHz to the RF OUTPUT on TF 2015A.

(3) Set the DEVIATION controls at x10 and 10 kHz respectively. The measured deviation should be within ±15% of 100 kHz. If necessary adjust SET MOD to obtain this requirement then reset A18R5 to position the pointer of the meter at centre of white box.

(4) Set the DEVIATION multiplier at x1. The measured deviation should be within ±15% of 10 kHz. If necessary adjust A19R12 to obtain this requirement.

Checking a.m. depth

Test equipment : item m or e.

20. (1) Set the FUNCTION selector at INT AM, set the CARRIER switch at ON. Set the frequency of TF 2015A at 20 MHz then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

(2) Set the AM DEPTH control at 80%.

(3) Connect the modulation meter to the RF OUTPUT on TF 2015A. Set the RF OUTPUT controls to provide a suitable input to the modulation meter then tune the modulation meter to TF 2015A.

(4) Check that the measured a.m. depth is between 70% and 90%.

(5) Repeat with the AM DEPTH control at 30% and check that the measured a.m. depth is between 25% and 35%. If necessary adjust A18R3 to obtain the best results for both 80% and 30% depths.

Note ...

If a modulation meter is not available the a.m. depth can be assessed by using the oscilloscope to measure the peak and trough values of the modulation envelope. The a.m. depth is then determined by :

$$\text{AM depth } \% = \frac{V_p - V_t}{V_p + V_t} \times 100$$

where V_p and V_t are the measured peak-to-peak and trough-to-trough amplitudes respectively.

Checking f.m. tracking

Test equipment : item m.

21. (1) Connect the modulation meter to the RF OUTPUT of TF 2015A.

(2) Set the FUNCTION selector at INT FM and the CARRIER switch at ON.

(3) Adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set the DEVIATION multiplier at x10 and the DEVIATION control at 10 kHz.

(4) Set the CARRIER RANGE selector at 10-14.3 and check that at frequencies 10, 12, and 14 MHz the measured deviation is 100 kHz ±15%.

Checking a.l.c. system

22. (1) Set the FUNCTION selector at CW and the CARRIER switch at ON then check that the pointer of the MOD/CARRIER meter is within the white box.

(2) Switch to each CARRIER RANGE in turn then use the TUNE control to check that over each frequency range the pointer of the MOD/CARRIER meter remains within the white box.

Counter output level

Test equipment : item i.

23. (1) Set the FUNCTION selector at CW and the CARRIER switch at ON.

(2) Connect the power meter to COUNTER OUT socket (rear of instrument) then check that with TF 2015A tuned to 100 MHz the output level is not less than -7 dBm.

External modulation sensitivity

Test equipment : item n.

24. (1) Set the FUNCTION selector at EXT AM and the CARRIER switch at ON.

(2) Using the external a.f. generator connected to the EXT MOD IN socket (rear of instrument) check that, with an input signal between 1.2 V and 1.5 V r.m.s. at frequencies of 30 Hz, 1.5 kHz, 10 kHz and 50 kHz, the pointer of the MOD/CARRIER meter can be positioned at the centre of the white box on scale.

(3) Repeat the above with FUNCTION selector at EXT FM.

Note ...

The TF 2015A meter can be overloaded if the applied a.f. input exceeds 10 V.

AM distortion

Test equipment : items l, m.

25. (1) Connect the test equipment as shown in Fig. 5.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON and the frequency of TF 2015A at 100 MHz. Then check that the pointer of the MOD/CARRIER meter is within the white box on meter scale.

(3) Set the FUNCTION selector at INT AM. Then adjust SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on scale.

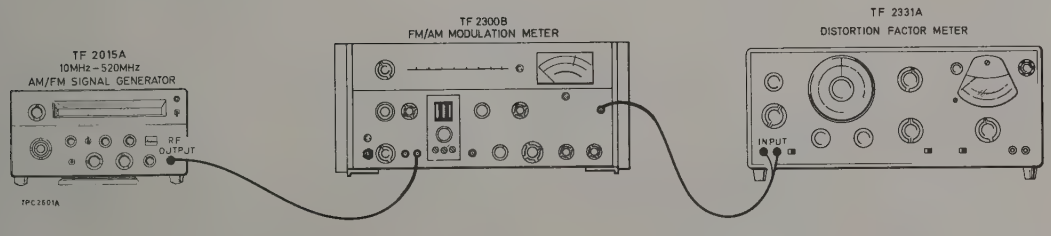

Fig. 5 Test gear arrangement to check f.m. and a.m. distortion and f.m. on a.m.

(4) Set the AM DEPTH control at 30%. Then tune the modulation meter to TF 2015A and check that the distortion indicated on the distortion factor meter is not greater than 5%.

(5) If required, repeat the check using the external a.f. generator for modulation frequencies at 50 Hz and 20 kHz.

FM distortion

Test equipment : items l, m.

26. (1) With the test equipment connected as in Fig. 5 repeat para. 25 (2). Then set the FUNCTION selector at INT FM, and the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

(2) Set the DEVIATION multiplier at x10 and the DEVIATION control at 10 kHz.

(3) Ensure that the modulation meter is tuned to TF 2015A. Then check that the distortion indicated on the distortion factor meter is not greater than 5%.

(4) If desired, repeat the check using the external a.f. generator for modulation frequencies at 30 Hz and 100 kHz.

Spurious f.m. on c.w.

Test equipment : items m, o.

27. (1) Connect the test equipment as in Fig. 6.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON and the frequency of TF 2015A to 174.5 MHz. Ensure that the pointer of the MOD/CARRIER meter is within the white box.

(3) Set the FUNCTION selector at INT FM. Adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

(4) Set the DEVIATION multiplier at x1 and the DEVIATION control to 5 kHz.

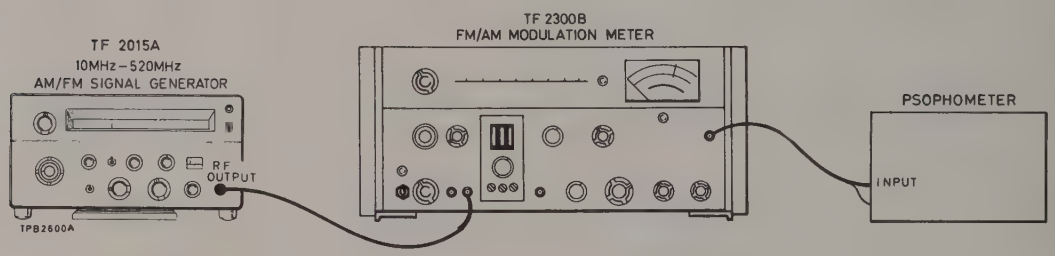

Fig. 6 Test gear arrangement to check spurious f.m. on c.w.

(5) Set the psophometer controls as follows :

INPUT SELECTOR :	Terminated
WEIGHTING :	FILTER NO. 1
ATTENUATOR :	0 dB

(6) Using 44 MHz crystal, tune and crystal lock the modulation meter to TF 2015A (modulation meter at 176.0 MHz). Then set the ADJUST CALIBRATION control on the psophometer for a meter indication of 0 dB.

(7) Set the FUNCTION selector at CW. Then adjust the psophometer attenuator to restore the meter pointer at 0 dB, and check that the change is greater than 38 dB (less than 61 Hz).

(8) If desired repeat the check at a carrier frequency of 481.5 MHz and check that the change is greater than 34 dB (less than 100 Hz).

Spurious a.m. on c.w.

Test equipment : items p, o.

28. (1) Connect the test equipment as shown in Fig. 7. Then with the FUNCTION selector at CW, the CARRIER switch at ON and TF2015A tuned to 100 MHz check that the pointer of the MOD/CARRIER meter is within the white box.

(2) Set the FUNCTION selector at INT AM. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

(3) Set the AM DEPTH control at 20% and the TF 2015A output at maximum.

(4) Set the Psophometer controls as follows :-

INPUT SELECTOR	:	THRO
WEIGHTING	:	FILTER No. 1 (telephone)
VOLTAGE/dBm RANGE	:	10 mV

(5) Switch the psophometer to INTERNAL SUPPLY. Then adjust the VOLTAGE/dBm RANGE switch and the ADJUST CALIBRATION control for a convenient indication on the meter. Note the setting of the VOLTAGE/dBm RANGE switch and the meter indication.

(6) Set the TF 2015A FUNCTION selector at CW. Then increase the VOLTAGE/dBM RANGE switch on psophometer by 40 dBm. The meter should indicate a level which is less than that noted in (5).

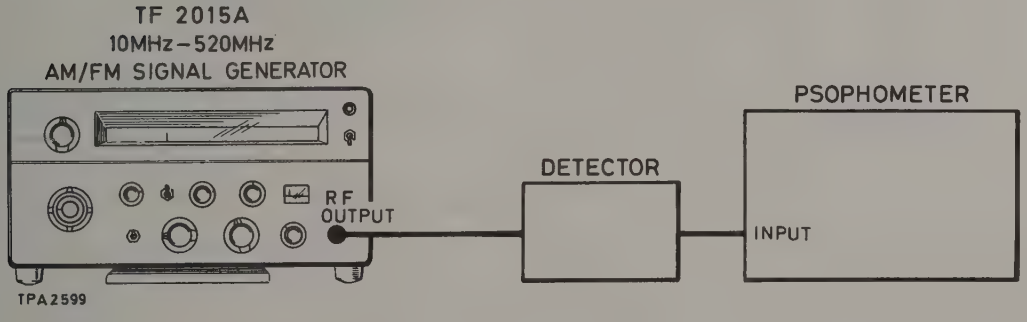

Fig. 7 Test gear arrangement to check spurious a.m. on c.w. and a.m. on f.m.

Spurious a.m. on f.m.

Test equipment : items p, o.

29. (1) With the test equipment connected as in Fig. 7 repeat para. 28 (1) and (2).

(2) Set the AM DEPTH control at 30% and the TF 2015A output at maximum.

(3) Set the psophometer controls as follows :-

INPUT SELECTOR	:	THRO
WEIGHTING	:	FILTER No. 1
VOLTAGE/dBm RANGE	:	10 mV

(4) Switch the psophometer to INTERNAL SUPPLY. Then adjust the VOLTAGE/dBm RANGE switch and the ADJUST CALIBRATION control for a convenient indication on the meter. Note the setting of the VOLTAGE/dBm RANGE switch and the meter indication.

(5) Set the TF 2015A FUNCTION selector at INT FM. Adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set DEVIATION multiplier at x10 and DEVIATION control at 3 (i.e. 30 kHz).

(6) Increase the VOLTAGE/dBm RANGE switch on psophometer by 20 dB. The meter should indicate a level which is not greater than that noted in (4).

Spurious f.m. on a.m.

Test equipment : items l, m.

30. (1) Connect the test equipment as in Fig. 5.

(2) Set the FUNCTION selector at INT FM, the CARRIER switch at ON, the TF 2015A frequency at 100 MHz and its output at maximum. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

(3) Set the DEVIATION multiplier at x1 and the DEVIATION control at 1 kHz then tune the modulation meter (preferably using crystal lock) to TF 2015A and ensure that the indicated deviation is 1 kHz.

(4) Set the FUNCTION selector on the distortion factor meter (d.f.m.) at SET REF LEVEL, the INPUT switch at HI Z, the INPUT range at 1 V - 10 V and the METER RANGE switch at 0.1 V. Then adjust the SET REF (d.f.m.) level control to give a meter indication of 0 dB.

(5) Set the TF 2015A FUNCTION selector at INT AM and adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set the AM DEPTH control at 30%.

(6) Note the difference in level shown on the d.f.m., using a more sensitive range if necessary, and ensure that it is greater than 6 dB, i.e. deviation less than 500 Hz.

$$\left(\text{Deviation in Hz} = \frac{1000}{\text{d.f.m. voltage ratio}}\right)$$

Carrier harmonics

Test equipment : item r.

31. (1) Connect the RF OUTPUT of TF 2015A to the r.f. input of the spectrum analyser.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON and the RF OUTPUT controls fully clockwise. Then ensure that the pointer of the MOD/CARRIER meter is within the white box.

(3) Tune TF 2015A through each r.f. range and check that the amplitude of any harmonic is greater than 26 dB down on the fundamental.

Coarse r.f. output control

Test equipment : items i, s.

32. Provided the attenuator pads have not been damaged (see Chap. 3, para. 5) it is only necessary to prove correct operation of the associated micro-switches and this can be satisfied by making a series of resistance measurements as follows :

(1) With the SUPPLY switch at OFF, connect the multimeter set at low ohms range to the RF OUTPUT socket.

(2) Set both RF OUTPUT controls fully clockwise and check that the multimeter indicates a resistance of 1050 Ω ±2% (resistor tolerance).

(3) Position the COARSE control in turn to each dB setting and check that the measured resistance at the 10 dB position is 60 Ω and at 20 dB position 51 Ω and each following position 50 Ω ±2% (resistor tolerance).

Reverse power protection

Test equipment b, e.

33. (1) Set the RF output controls to 127 dB.

(2) Connect the TF 2016A and oscilloscope in parallel with the TF 2015A output.

(3) Set the TF 2016A to 10 MHz and 200 mV, observe the waveform on the oscilloscope.

(4) Slowly increase the TF 2016A voltage and note that above 0.6 V r.m.s., the waveform limits progressively on both halves of the waveform.

Fine r.f. output control

Test equipment : item i.

34. (1) Connect the power meter to the RF OUTPUT socket.

(2) Set the SUPPLY switch at ON, the FUNCTION selection at CW, the CARRIER switch at ON. Tune the TF 2015A to 100 MHz and check that the pointer of the MOD/CARRIER meter is within the white box.

(3) Set the COARSE control at 0 and the FINE control at 7 dB then note the reading obtained on the power meter.

(4) Repeat check (3) with the FINE control in turn at 9, 11, 13, 15, and 17 dB positions.

CLEANING ROTARY SWITCHES

35. If it is necessary to clean the contacts of any rotary switches, this should be done with benzine or white spirit (not carbon tetrachloride) and the contacts should afterwards be wiped with a suitable lubricant such as a 1% solution of petroleum jelly in white spirit. Avoid lubricants containing soap or solid materials.

FAULT LOCATION

36. Some aid to fault finding is provided by the typical d.c. voltage and signal levels given in paras. 37 to 42 and by the fault tables included in each of the following sections. The tables are not extensive but are intended as a pointer to further investigation. It is to be emphasized that each fault table should be studied having regard for the others since incorrect operation of a circuit may be caused by malfunction of an associated circuit.

DC voltages

Test equipment : item s.

37. Voltages given on the circuit diagrams and in Tables 2 and 3 approximate those which can be expected when using a 20 kΩ/V meter on a typical TF 2015A connected to an a.c. supply of 240 V, 50 Hz. Unless stated otherwise the voltages were measured with the controls of the TF 2015A positioned as follows :

CARRIER FREQUENCY	:	at 14 MHz RANGE 1
CARRIER switch	:	at ON
FUNCTION selector	:	at INT AM
RF OUTPUT controls	:	at 0 and -7 dB

Note ...

Prior to making measurements ensure that screws on Unit A12 are tight.

38. Voltage levels at A12 pin 12 are dictated by the a.l.c. voltage at A17 pin 5 and should approximate those given in Table 2.

TABLE 2 VOLTAGE LEVELS : UNIT A12

Range TF 2015A	Frequency MHz	Voltage (V d.c.) at A12 pin 12
1-7	10-124	9-11
8	124	8.6
	177	9.7
9	177	9.2
	250	9.8
10	250	4.3
	320	8.0
	360	6.5
11	360	7.0
	410	9.2
	520	8.3

39. Voltage levels on Unit A23 which were measured with TF 2015A set in turn to 10 MHz and 14 MHz (RANGE 1) with CARRIER switch at ON and f.m. at 100 kHz deviation should approximate those given in Table 3.

TABLE 3 VOLTAGE LEVELS : UNIT A23

Test point	Voltage (V d.c.) 10 MHz	14 MHz	Meter range (V)	Remarks
Junction R1/D1	4.7	7.5	100	
Junction C2/D1	0	7.5	100	
Junction R4/D2	0.2	0.25	2.5	Negative with respect to chassis
Junction R2/D2	0.03	0.03	2.5	

TABLE 4 RF SIGNAL LEVELS

Unit	Test point	Range 1 Signal level (mV) 14 MHz		Range 11 Signal level (mV) 520 MHz	
		Carrier switch		Carrier switch	
		On	+6 dB	On	+6 dB
A12	Pin 14	54	-	69	-
A16	Pin 1	53	-	24	-
	Junction R2/R4	9	-	28	-
	TR1e	2	-	1.8	-
	TR1c	20	-	28	-
	TR2c	140	-	145	-
	TR3e	7	-	46	-
	TR3c	37	-	38	-
	TR4c	330	-	230	-
	Junction D3/D5	175	180	94	65
	Junction D3/D4	23	67	27	125
	Junction D4/D6	170	180	103	158
	Junction D5/D6	24	68	31	118
	Junction C19/T2	45	125	15.5	77
	TR5b	5.5	11	20	90
	TR5c	80	260	84	310
	TR7b	6.2	13.5	37	81
	TR7c	105	210		205
	TR8b	9.4	19.5	96	200
	TR8c	205*	400	265*	490
	TR6b	67*	-	38*	-
	TR6c	690*	-	155*	-
	Pin 7	2ø	2.5ø	8.5ø	24ø

* SKF (COUNTER OUTPUT) loaded with 50 Ω.

ø Spurious r.f. levels present on the +22 V d.c. line measured with TF 2603 earth probe connected to earth track on printed board and close to TR8.

RF signal levels

Test equipment : item g.

40. The r.f. signal levels listed in Table 4 approximate those which can be expected using the specified meter on a typical TF 2015A connected to an a.c. supply of 240 V, 50 Hz.

41. Measurements were made with the TF 2015A FUNCTION selector at CW, the RF OUTPUT controls at 0 and 7 dB and with the earth probe of TF 2603 connected to a position on the earth track on the printed board close to the test point.

AF signal levels

Test equipment : item e.

42. The a.f. signal levels listed in Table 5 approximate those which can be expected on a typical TF 2015A connected to an a.c. supply of 240 V, 50 Hz. Unless stated otherwise,

measurements were made with TF 2015A set at 14 MHz RANGE 1 and CARRIER switch at ON.

TABLE 5 AF SIGNAL LEVELS

Unit	Control settings	Test point	Signal level	Remarks
A19	FUNCTION - INT FM	Pin 3	6.7 V p-p	
	DEVIATION - 100 kHz	Pin 7	3.2 V p-p	Negative peak compressed
		Pin 18	6.4 V p-p	
		Pin 17	1 V p-p	Negative peak compressed
		Pin 9	3 V p-p	
A21	FUNCTION - INT FM	Pin 15	0.5 V p-p	
	DEVIATION - 100 kHz	Pin 13	205 mV p-p	Carrier frequency 10 MHz
A21	FUNCTION - INT AM	Pin 6	850 mV p-p	
	AM DEPTH - 80%	Pin 8	58 mV p-p	Negative peak compressed
		Pin 9	70 mV p-p	Negative peak compressed

Power supply

Circuit diagram Chap. 7, Fig. 1, Unit A20

43. Typical power supply fault conditions are listed in Table 6.

TABLE 6 POWER SUPPLY FAULTS

Fault	Probable cause
(a) Fuse FS1 and/or FS3 blows when instrument is switched on.	Short in a.c. input circuit A0C1 or C2 short- or partial short-circuit.
(b) No 22 V output.	A0TR1 open-circuit (check 22 V line for short). A0C1, C2 or C5 short- or partial short-circuit.
(c) No 19 V output.	TR4 open-circuit (check 19 V line for short).
(d) Inability to set 22 V ±100 mV.	TR2, TR3 or TR5 faulty. Resistor open-circuit or value changed. C3 or C4 short- or partial short-circuit.
(e) Incorrect 19 V ±100 mV output.	Faulty TR5, TR6, TR8. Resistor open circuit or value changed especially R9, R14 or R17.
(f) 100 Hz supply on 22 V line greater than 100 μV r.m.s.	A0C1, C2 or C3 open-circuit or low capacitance. D1, D2, D3 or D4 faulty.
(g) 100 Hz supply on 19 V line greater than 1 μV r.m.s.	C8 open circuit or low capacitance.

RF frequency calibrations

Circuit diagram Chap. 7, Fig. 2, Unit A12 (sub-assemblies A1 to A11)

44. Typical frequency calibration fault conditions are listed in Table 7.

TABLE 7 FREQUENCY CALIBRATION FAULTS

Fault	Probable cause
(a) Calibrations incorrect all ranges.	Incorrect d.c. voltage at A19 pin 8. Check d.c. path to switch SG.
(b) Inability to set scale calibrations on any selected range.	Incorrect d.c. voltage to R4 (A1 to A9) R5 (A10 and A11). Check output A21 pin 13. Faulty varactor D1 or D2.

RF output (normal)

Circuit diagram Chap. 7, Figs. 1 and 3, Units A16, A17, A18

45. Typical r.f. output fault conditions are listed in Table 8.

TABLE 8 RF OUTPUT FAULTS

Fault	Probable cause
Meter pointer not within white box.	Incorrect d.c. outputs A18 pins 12 or 13. Check circuit A18 TR2. Faulty resistor or diode in circuit A18R13 to R21, D4 or D5. Incorrect operation of circuit A17, R1 to R7, TR1, TR2 or TR3. DC offsets to A16 modulator from A17TR7 and TR8 at incorrect level. Check circuit TR7 and TR8. Fault in amplifier circuit A16TR5, TR7 and TR8. D7 or D8 faulty. Fault in a d.c. circuit of A17. Check TR9, TR10, IC1 and A16D9 and D10.

RF output (+6 dB)

46. Typical r.f. output (+6 dB) fault conditions are listed in Table 9.

TABLE 9 RF OUTPUT (+6 dB) FAULTS

Fault	Probable cause
+6 dB output not obtainable.	Faulty carrier switch. Faulty diode A18D6 or R25. Recheck operation of circuits A17TR7, TR8 for increased d.c. offsets to A16 modulator and operation of a.l.c. loop with carrier switch at +6 dB.

VSWR

47. Check A0R39 (A16 r.f. output) is 50 Ω ±1% and recheck A22 as described in para. 32.

Modulation oscillator

Circuit diagram Chap. 7, Fig. 1, Unit A19

48. Typical modulation oscillator faults are listed in Table 10.

TABLE 10 MODULATION OSCILLATOR FAULTS

Fault	Probable cause
(a) No output or incorrect output.	No 22 V at pin 1 : check switch SA1F. TR1 or TR2 faulty.
(b) Frequency incorrect.	Check switch SH. R1, R2, C1, C2 faulty; check values.
(c) Distortion greater than 0.25%.	Faulty thermistor R7. Check C3, C4.

Amplitude modulation

Circuit diagram Chap. 7, Figs. 1 & 3, Units A16, A17, A18

49. Typical amplitude modulation faults are listed in Table 11.

TABLE 11 AMPLITUDE MODULATION FAULTS

Fault	Probable cause
(a) Inability to set meter pointer at centre of white box by adjusting SET MOD control.	A0R2 faulty. Fault in monitor circuit A18TR1.
(b) Inability to obtain required modulation depth.	Fault in a.m. driver circuit A17TR4, TR5 or TR6. Incorrect operation of modulator : check A16D3 to D6, L1 and L2. Check A16C17, C18 and a.f. path from SET MOD control to driver.
(c) Envelope distortion.	Fault in modulation oscillator. Fault in a.m. driver circuit.

Frequency modulation

Circuit diagram Chap. 7, Fig. 1, Units A18, A19 and A23

50. Typical frequency modulation faults are listed in Table 12.

TABLE 12 FREQUENCY MODULATION FAULTS

Fault	Probable cause
No frequency modulation.	Check a.f. path from SET MOD control to A23. Incorrect operation of circuits A18, A19 or A23. Switch SG faulty.
Incorrect deviation.	Faulty resistor A0R5 to R15, A19R18 to R22 or R17. Check switch SC and A18R30 and R32.
FM distortion.	Incorrect operation of circuits A18, A19 or A23.

ALC system

Circuit diagram Chap. 7, Figs. 1 & 3, Units A16, A17, A18

51. Typical a.l.c. faults are listed in Table 13.

TABLE 13 ALC FAULTS

Fault	Probable cause
Meter pointer at zero or full-scale - all ranges.	Fault in r.f. signal path. Check outputs from circuits on A16. Fault in circuit A17TR7, TR8. Fault in circuit A17TR9, TR10, IC1. Fault in circuit A18TR2 : check outputs. Check diodes D4, D5 and associated resistors.
- on one range only	No input to A16 pin 1 : suspect appropriate oscillator output.

Carrier harmonics

Circuit diagram Chap. 7, Fig. 3, Units A16 and A17

52. Typical carrier harmonic faults are listed in Table 14.

TABLE 14 CARRIER HARMONIC FAULTS

Fault	Probable cause
Amplitude too high - all ranges	Incorrect operation of first a.l.c. loop, causing high oscillator outputs to overload pre-amplifier. Amplifier distortion : check circuits TR1 to TR4 and TR5, TR7 and TR8.

Spurious modulation

53. Typical spurious modulation faults are listed in Table 15.

TABLE 15 SPURIOUS MODULATION FAULTS

Fault	Probable cause
Spurious f.m. or a.m. too high	Excess ripple on 22 V or 19 V d.c. supplies or increased circuit noise. Check transistors, diodes, and if necessary resistors especially those incorporated in a.l.c. loops.

REPLACING TUNING DRIVE CORD

54. The procedure for fitting a new drive cord is given below. A drive cord consists of 1 metre of nylon cord (Part No. 16410-604V). A new tension spring (Part No. 31119-017X) may also be required.

(1) Remove the case from the instrument and remove the attenuator unit (see Chap. 5, para. 8).

(2) Remove the scale plates for the three highest frequency ranges.

(3) Set the RANGE switch to the 14.3 - 20.5 MHz position.

(4) Stand the instrument upside-down on the bench.

(5) Referring to Fig. 8, slacken the grub screws and unscrew the nut to pull aside R38. With the TUNE control three steps away from the fully counter-clockwise position, slacken one of the grub screws in the cord-drum boss. Turn the TUNE control fully clockwise and slacken the other grub screw. Remove the TUNE and EXTRA FINE TUNE knobs. Unscrew the nut and pull away the switch assembly SG from the drum.

(6) Remove the drum and attach the drive cord as shown in Fig. 8, temporarily holding it in place with adhesive tape. Seal the cord knots with bakelite varnish.

(7) Replace the drum and completely refit the switch SG and R38 assemblies.

(8) Fit the loop of cord around the three pulleys. Check that the cord spring is under tension. If the cord has been properly dimensioned, the expanded length of the spring will be about 12 mm ($\frac{1}{2}$ inch). Refit the knobs.

(9) Attach the pointer to the drive cord and adjust its position so that it reaches (or just passes) the 60 MHz and 124 MHz calibration marks :

  (a) On 60 - 86 MHz range with both TUNE and FINE TUNE controls fully counter-clockwise.

  (b) On 86 - 124 MHz range with both TUNE and FINE TUNE controls fully clockwise.

(10) Refit scale plates, attenuator unit and case.

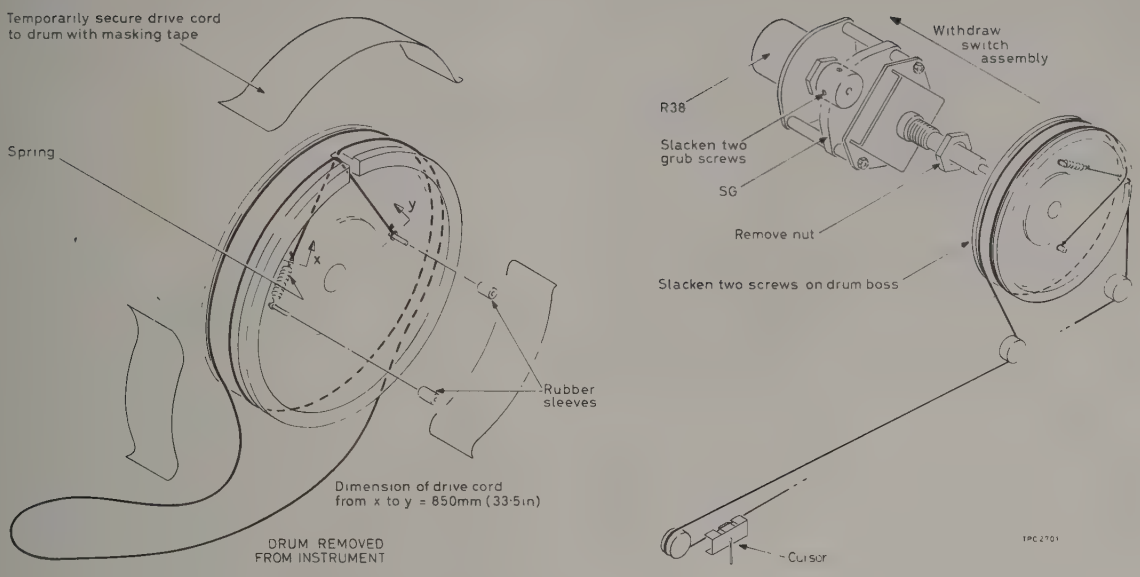

Fig. 8 Replacing cord drive.

REPLACING TRANSFORMERS A16 - T1, T2

55. If modulator transformers T1 or T2 are required to be replaced it is important that the replacement be connected in the same way as the removed component. The required connections are shown in Fig. 9.

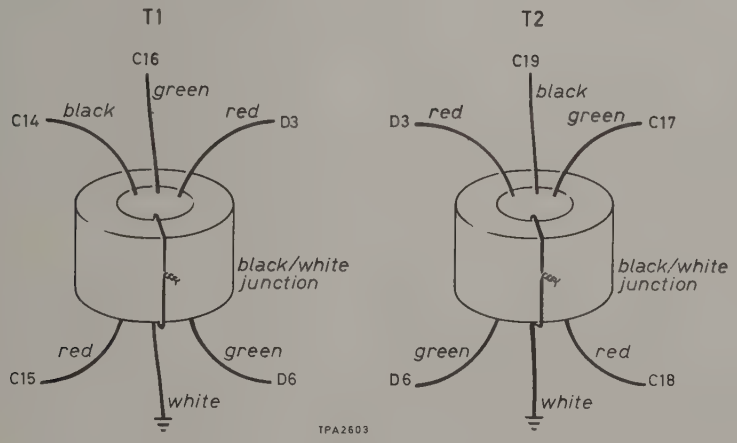

Fig. 9 Transformer connections A16 - T1 & T2.

ADDITIONAL INFORMATION

56. If further information is required please write or telephone Marconi Instruments Limited, Service Division - see address on back cover - or contact our nearest representative, quoting the type and serial number on the data plate on rear of instrument. If the instrument is being returned for repair please indicate clearly the nature of the fault or the work you require to be done.

Chapter 6

REPLACEABLE PARTS

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INTRODUCTION

1. Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification in the sequence A0 to A12 and A16 to A23.

2. The complete component reference carries its unit number as a prefix e.g. A0C3 (capacitor C3 on the main chassis assembly) but for convenience in the text and on circuit diagrams the prefix is not used. However, when ordering replacements or in correspondence the complete component reference must be quoted.

ABBREVIATIONS

3. The components are listed in alphanumerical order of the complete circuit reference and the following abbreviations are used :

C	:	capacitor	Plas	:	plastic dielectric
Carb	:	carbon	R	:	resistor
Cer	:	ceramic	S	:	switch
Cerm	:	cermet	SK	:	socket
D	:	semiconductor diode	T	:	transformer
Elec	:	electrolytic	Tant	:	tantalum
FS	:	fuse	TP	:	terminal
IC	:	integrated circuit (package)	TR	:	transistor
L	:	inductor	Var	:	variable
ME	:	meter	W	:	watts at 70°C
Met	:	metal	WW	:	wirewound
Mic	:	mica	X	:	ferrite bead
Ox	:	oxide	†	:	values selected during test; nominal value listed
Pl	:	plug	Ø	:	feed-through component

COMPONENT VALUES

4. One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons :

(1) Components indicated by † have their values selected during test to achieve particular performance limits.

(2) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(3) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

5. When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

TUNING DIODES REPLACEMENT

6. When ordering replacement diodes D1 and D2 for oscillator units A1 to A11, it is necessary to ensure that diodes of the correct voltage/capacitance characteristic are supplied by following the instructions given below.

7. On the mother board, unit A12, there is a label bearing a letter and a number to identify the particular group of diodes used. To obtain the correct replacement your order should call for :

(1) Type and serial number of instrument.

(2) Complete circuit reference e.g. A1D2.

(3) Description i.e. Diode BB 105A.

(4) Marconi Instruments part no. 44529-003P plus group identification code e.g. 44529-003P/D3.

ORDERING

8. When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required :

(1) Type* and serial number of instrument.

(2) Complete circuit reference.

(3) Description.

(4) Marconi Instruments part no.

* As given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

Unit A0 : Main chassis assembly

Circuit ref.	Description	Part no.
9.	When ordering, prefix circuit reference with A0.	
C1	Elec 2200µF +50-10% 40V	26426-086D
C2 to C25	Cer Ø 0.001µF +80-20% 300V	26373-733K
C26	Cer Ø 50pF 10% 300V	26333-229U
C27	Cer Ø 50pF 10% 300V	26333-229U
C28	Cer Ø 50pF 10% 300V	26333-229U
C29 to C35	Cer Ø 500pF +80-20% 300V	26373-732B
C36	Cer Ø 50pF 10% 300V	26333-229U
C37	Cer Ø 500pF +80-20% 300V	27383-732B
C38 †	Elec 22µF 20% 15V	26486-583L
D1	LED (On-Off indicator)	28624-103S
FS1	160mA slow-blow (190-264V)	23411-054T
	or 250mA slow-blow (95-132V)	23411-055P
	Holder for FS1	23416-191C
FS2	500mA slow-blow	23411-056X
	Holder for FS2	23416-191C
FS3	160mA slow-blow (190-264V)	23411-054T
	or 250mA slow-blow (95-132V)	23411-055P
	Holder for FS3	23416-191C
	Cover for FS1 and FS3	23416-198E
L1	Choke 100µH	23642-561W
L2	Choke 100µH	23642-561W
L3	Choke 100µH	23642-561W
L4	Choke 100µH	23642-561W
L5	Choke 100µH	23642-561W
L6	Choke 100µH	23642-561W
L7	Choke 100µH	23642-561W
L8	Choke 100µH	23642-561W
L9	Choke 100µH	23642-561W
L10	Choke 100µH	23642-561W
L11	Choke 10µH	23642-555G
L12	Choke 10µH	23642-555G
L13	Choke 100µH	23642-561W
L14	Choke 100µH	23642-561W
L15	Choke 10µH	23642-555G
L16	Choke 10µH	23642-555G
L17	Choke 100µH	44290-487G
L18	Choke 100µH	44290-487G
L21	Coil assembly	44290-245L
L22	Coil assembly	44290-245L
L23	Coil assembly	44290-246J

Unit A0 : Main chassis assembly (continued)

Circuit ref.	Description	Part no.
ME1	Meter	44559-015Y
R1	Cerm 1kΩ 10% 2W	25725-403N
R2	Cerm 1kΩ 10% 2W	25725-403N
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Cerm 1kΩ 10% 2W	25725-403N
R5	Met film 2.2kΩ 2% 1/4W	24773-281Y
R6	Met film 1.5kΩ 2% 1/4W	24773-277U
R7	Met film 1.1kΩ 2% 1/4W	24773-274Z
R8	Met film 750Ω 2% 1/4W	24773-270R
R9	Met film 510Ω 2% 1/4W	24773-266C
R10	Met film 360Ω 2% 1/4W	24773-262T
R11	Met film 240Ω 2% 1/4W	24773-258D
R12	Met film 180Ω 2% 1/4W	24773-255V
R13	Met film 120Ω 2% 1/4W	24773-251L
R14	Met film 130Ω 2% 1/4W	24773-252J
R15	Met film 150Ω 2% 1/4W	24773-253F
R5 to R15	(inclusive) mounted on RANGE switch SD	
R16	Cerm 10kΩ 10% 2W	25725-404L
R17	Met film 1.1kΩ 2% 1/4W	24773-274Z
R18	Met film 750Ω 2% 1/4W	24773-270R
R19	Met film 680Ω 2% 1/4W	24773-269K
R20	Met film 560Ω 2% 1/4W	24773-267R
R21	Met film 510Ω 2% 1/4W	24773-266C
R22	Met film 430Ω 2% 1/4W	24773-264X
R23	Met film 430Ω 2% 1/4W	24773-264X
R24	Met film 390Ω 2% 1/4W	24773-263P
R25	Met film 360Ω 2% 1/4W	24773-262T
R26	Met film 330Ω 2% 1/4W	24773-261D
R27	Met film 300Ω 2% 1/4W	24773-260W
R28	Met film 300Ω 2% 1/4W	24773-260W
R29	Met film 240Ω 2% 1/4W	24773-258D
R30	Met film 220Ω 2% 1/4W	24773-257W
R31	Met film 200Ω 2% 1/4W	24773-256S
R32	Met film 180Ω 2% 1/4W	24773-255V
R33	Met film 160Ω 2% 1/4W	24773-254G
R34	Met film 130Ω 2% 1/4W	24773-252J
R35	Met film 120Ω 2% 1/4W	24773-251L
R36	Met film 100Ω 2% 1/4W	24773-249J
R17 to R36	(inclusive) mounted on TUNE switch SG.	
R37	WW 100kΩ 10% 10-turn 0.8W	25885-031A
R38	WW 10kΩ 10% ½W	25812-696B
R39	Met film 50Ω 1% 1/4W	24762-558R
R40	Met film 200Ω 2% 1/4W	24773-256S

Circuit ref.	Description	Part no.
Unit A0 : Main chassis assembly (continued)		
R41	Met film 820Ω 2% 1/4W	24773-271B
R42 †	Met film 2.2kΩ 2% 1/4W	24773-281Y
R43	WW 470Ω 5% 1½W	25123-067B
SA	FUNCTION switch	44340-022C
SB	CARRIER switch 4-pole, 3-pos.	23462-267W
SC	DEVIATION multiplier switch SPDT (on-off-on)	23462-254E
SD1	Front wafer of CARRIER RANGE switch	44340-031H
SD2	Rear wafer of CARRIER RANGE switch	44340-030Z
SE	SUPPLY switch DPDT	23462-258L
SF	VOLTAGE SELECTOR switch 230V/115V	23467-161W
SG	TUNE switch	44340-015T
SKA	Bulgin P580	23423-159P
SKB	BNC 50Ω (Ext mod in)	23443-443K
SKC	BNC 50Ω (Int mod out)	23443-443K
SKD	BNC 50Ω (Sync in)	23443-443K
SKE	DIN speaker type (IF probe supply)	23435-252Y
SKF	TNC 50Ω (counter out)	23444-741Z
	Cap and chain for SKF	23444-898M
SKG	BNC 50Ω	23444-382T
SKH	BNC 50Ω (RF out)	43129-029G
T1	Mains transformer	43490-010Z

Circuit ref.	Description	Part no.
TP1	Battery terminal + input	23235-176V
TP2	Battery terminal - input	23235-176V
TR1	Transistor 2N3055	28456-567W
X1 to X40	Ferrite bead	41372-006T
Unit A1 : Oscillator range 1 (Sub-assembly of Unit A12)		
10.	When ordering, prefix circuit reference with A1.	
	Complete board	44827-137X
C1	Cer 0.01µF +80-20% 100V	26383-055L
C2 †	Cer 10pF ±0.5pF 500V	26343-121K
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6
D2	Tuning varactor BB105A	tuning diodes
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T

Circuit ref.	*Description*	*Part no.*
Unit A1 : Oscillator range 1 (continued)		
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
R6 †	Met film 22kΩ 2% 1/4W	24773-305K
T1	Coil assembly	44290-079W
TR1	WN428	28459-025A
Unit A2 : Oscillator range 2 (sub-assembly of Unit A12)		
11.	When ordering, prefix circuit reference with A2.	
	Complete board	44827-138M
C1	Cer 0.01µF +80-20% 100V	26383-055L
C2 †	Cer 12pF 10% 500V	26343-125E
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6
D2	Tuning varactor BB105A	tuning diodes
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T

Circuit ref.	*Description*	*Part no.*
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
R6 †	Met film 22kΩ 2% 1/4W	24773-305R
T1	Coil assembly	44290-080V
TR1	WN428	28459-025A
Unit A3 : Oscillator range 3 (sub-assembly of Unit A12)		
12.	When ordering, prefix circuit reference with A3.	
	Complete board	44827-139C
C1	Cer 0.01µF +80-20% 100V	26383-055L
C2 †	Cer 15pF ±0.5pF 500V	26343-127Y
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6
D2	Tuning varactor BB105A	tuning diodes
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T

Circuit ref.	Description	Part no.
Unit A3 : Oscillator range 3 (continued)		
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-081S
TR1	Transistor WN428	28459-025A

Circuit ref.	Description	Part no.
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-082W
TR1	Transistor WN428	28459-025A

Unit A4 : Oscillator range 4 **(sub-assembly of Unit A12)**

13. When ordering, prefix circuit reference with A4.

	Complete board	44827-140X
C1	Cer 0.001µF +80-20% 500V	26383-242P
C2 †	Cer 10pF ±0.5pF 500V	26343-121K
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	

Unit A5 : Oscillator range 5 **(sub-assembly of Unit A12)**

14. When ordering, prefix circuit reference with A5.

	Complete board	44827-141M
C1	Cer 0.001µF +80-20% 500V	26383-242P
C2 †	Cer 10pF ±0.5pF 500V	26343-121K
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	

Circuit ref.	Description	Part no.
Unit A5 : Oscillator range 5 (continued)		
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-083D
TR1	Transistor WN428	28459-025A

Unit A6 : Oscillator range 6 (sub-assembly of Unit A12)

15. When ordering, prefix circuit reference with A6.

	Complete board	44827-142C
C1	Cer 0.001µF +80-20% 500V	26383-242P
C2 †	Cer 7.5pF ±0.5pF 500V	26343-117B
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	

Circuit ref.	Description	Part no.
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-084T
TR1	Transistor WN428	28459-025A

Unit A7 : Oscillator range 7 (sub-assembly of Unit A12)

16. When ordering, prefix circuit reference with A7.

	Complete board	44827-143R
C1	Cer 680pF +40-20% 500V	26383-141X
C2 †	Cer 7.5pF ±0.5pF 500V	26343-117B
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	

Circuit ref.	*Description*	*Part no.*
Unit A7 : Oscillator range 7 (continued)		
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-085P
TR1	Transistor WN428	28459-025A
Unit A8 : Oscillator range 8 (sub-assembly of Unit A12)		
17.	When ordering, prefix circuit reference with A8.	
	Complete board	44827-144B
C1	Cer 470pF +40-20% 500V	26383-139M
C2 †	Cer 12pF 10% 500V	26343-125E
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T

Circuit ref.	*Description*	*Part no.*
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-086X
TR1	Transistor WN428	28459-025A
Unit A9 : Oscillator range 9 (sub-assembly of Unit A12)		
18.	When ordering, prefix circuit reference with A9.	
	Complete board	44827-145K
C1	Cer 330pF 20% 500V	26383-136T
C2 †	Cer 10pF ±0.5pF 500V	26343-121K
C3	Cer 220pF 20% 500V	26383-134W
C4	Cer var. 0.5-5pF	26845-141K
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 300kΩ 2% 1/4W	24773-332T
R2	Met film 300kΩ 2% 1/4W	24773-332T
R3	Met film 1kΩ 2% 1/4W	24773-273A
R4	Met film 10kΩ 2% 1/4W	24773-297M

Circuit ref.	*Description*	*Part no.*
Unit A9 : Oscillator range 9 (continued)		
R5	Met film 100Ω 2% 1/4W	24773-249J
T1	Coil assembly	44290-087M
TR1	Transistor WN428	28459-025A
Unit A10 : Oscillator range 10		
	(Oscillator is assembled onto A12 board)	
19.	When ordering, prefix circuit reference with A10.	
C1	Cer 220pF 20% 500V	26383-134W
C2	Cer 2.2pF 0.5% 500V	26343-110D
C3	Cer 100pF 20% 500V	26343-167G
C4	Cer var. 0.5-5pF	26845-141K
C5	Cer 68pF 20% 500V	26343-163N
C6	Cer 2.2pF 0.25% 750V	26324-011H
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	
D3	1N4148	28336-676J
R1	Met film 4.7kΩ 2% 1/4W	24773-289W
R2	Met film 10kΩ 2% 1/4W	24773-297M
R3	Met film 10kΩ 2% 1/4W	24773-297M
R4	Met film 2.2kΩ 2% 1/4W	24773-281Y

Circuit ref.	*Description*	*Part no.*
R5	Met film 10kΩ 2% 1/4W	24773-297M
R6	Met film 100Ω 2% 1/4W	24773-249J
R7	Carb 22Ω 5% 1/4W	24312-788U
L1	Oscillator inductor	-
TR1	Transistor BFR90	28452-167U
Unit A11 : Oscillator range 11		
	(Oscillator is assembled onto A12 board)	
20.	When ordering, prefix circuit reference with A11.	
C1	Cer 100pF 20% 500V	26343-167G
C2 †	Cer 4.7pF 20% 500V	26343-113X
C3	Cer 100pF 20% 500V	26343-167G
C4	Cer var. 0.5-5pF	26845-141K
C5	Cer 68pF 20% 500V	26343-163N
D1	Tuning varactor BB105A	See para. 6 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 4.7kΩ 2% 1/4W	24773-289W
R2	Met film 10kΩ 2% 1/4W	24773-297M
R3	Met film 10kΩ 2% 1/4W	24773-297M
R4	Met film 1kΩ 2% 1/4W	24773-273A
R5	Met film 10kΩ 2% 1/4W	24773-297M

Circuit ref.	Description	Part no.
Unit A11 : Oscillator range 11 (continued)		
R6	Met film 100Ω 2% 1/4W	24773-249J
R7	Carb 22Ω 5% 1/4W	24312-788U
L1	Oscillator inductor	
TR1	Transistor BFR90	28452-167U
Unit A12 : Mother board		
21.	When ordering, prefix circuit reference with A12.	
	Complete board (includes units A1 to A11)	44827-148H
C1	Cer 0.01µF +80-20% 100V	26383-055L
C2	Cer 0.01µF +80-20% 100V	26383-055L
C3	Cer 0.01µF +80-20% 100V	26383-055L
C4	Cer 0.001µF +80-20% 500V	26383-242P
C5	Cer 0.001µF +80-20% 500V	26383-242P
C6	Cer 0.001µF +80-20% 500V	26383-242P
C7	Cer 0.001µF +80-20% 500V	26383-242P
C8	Cer 100pF 20% 500V	26343-167G
C9	Cer 68pF 20% 500V	26343-163N
C10	Cer 470pF +40-20% 500V	26383-139M
C11	Cer 100pF 20% 500V	26343-167G
C12	Cer 0.01µF +80-20% 100V	26383-055L
C13	Cer 0.01µF +80-20% 100V	26383-055L
C14	Cer 0.001µF +80-20% 500V	26383-242P
C15	Cer 0.001µF +80-20% 500V	26383-242P
C16	Cer 0.001µF +80-20% 500V	26383-242P
C17	Cer 0.001µF +80-20% 500V	26383-242P
C18	Cer 0.001µF +80-20% 500V	26383-242P
C19	Cer 470pF +40-20% 500V	26383-139M
C20	Cer 470pF +40-20% 500V	26383-139M
D1	1N3062	28336-248R
D2	1N3062	28336-248R
D3	1N3062	28336-248R
D4	1N3062	28336-248R
D5	1N3062	28336-248R
D6	1N3062	28336-248R
D7	1N3062	283361248R
D8	1N3062	28336-248R
D9	1N3062	28336-248R
D10	1N3062	28336-248R
D11	1N3062	28336-248R
D12	1N3062	28336-248R
D13	1N4148	28336-676J
R1	Met film 100kΩ 2% 1/4W	24773-321L
R2	Met film 1.8kΩ 2% 1/4W	24773-279N
R3	Met film 100Ω 2% 1/4W	24773-249J
R4	Met film 100Ω 2% 1/4W	24773-249J

Circuit ref.	*Description*	*Part no.*
Unit A12 : Mother board (continued)		
R5	Met film 100Ω 2% 1/4W	24773-249J
R6	Met film 100Ω 2% 1/4W	24773-249J
R7	Met film 100Ω 2% 1/4W	24773-249J
R8	Met film 100Ω 2% 1/4W	24773-249J
R9	Met film 100Ω 2% 1/4W	24773-249J
R10	Met film 100Ω 2% 1/4W	24773-249J
R11	Met film 100Ω 2% 1/4W	24773-249J
R12	Met film 100Ω 2% 1/4W	24773-249J
R13	Met film 100Ω 2% 1/4W	24773-249J
X1	Ferrite bead	41372-006T
X2	Ferrite bead	43172-006T
Unit A16 : Pre-amplifier, modulator, counter amplifier, wide band amplifier		
22.	When ordering, prefix circuit reference with A16.	
	Complete board	44827-152E
C1	Cer 0.001µF +80-20% 500V	26383-242P
C2	Cer 0.001µF +80-20% 100V	26383-055L
C3	Cer 0.001µF +80-20% 500V	26383-242P
C4	Cer 0.001µF +80-20% 500V	26383-242P
C5	Cer 10pF 20% 500V	26343-120B
C7	Cer 0.01µF +80-20% 100V	26383-055L
C8	Cer 0.01µF +80-20% 100V	26383-055L
C9	Cer 0.001µF +80-20% 500V	26383-242P
C10	Cer 0.01µF +80-20% 100V	26383-055L
C11	Cer 0.01µF +80-20% 100V	26383-055L
C12	Cer 1pF ±0.5pF 500V	26343-101J
C13	Cer 0.01µF +80-20% 100V	26383-055L
C14	Cer 0.001µF +80-20% 500V	26383-242P
C15	Cer 0.001µF +80-20% 500V	26383-242P
C16	Cer 0.001µF +80-20% 500V	26383-242P
C17	Cer 0.001µF +80-20% 500V	26383-242P
C18	Cer 0.001µF +80-20% 500V	26383-242P
C19	Cer 0.001µF +80-20% 500V	26383-242P
C20	Cer 0.1µF +50-25% 30V	26383-031S
C21†	Cer 3.3pF ±5% 50V	26343-459K
C22	Cer 0.001µF +80-20% 500V	26383-242P
C23	Cer 0.01µF +80-20% 100V	26383-055L
C24	Cer 0.01µF +80-20% 100V	26383-055L
C25	Cer 0.001µF +80-20% 500V	26383-242P
C26	Cer 0.01µF +80-20% 100V	26383-055L
C27	Cer 0.001µF +80-20% 500V	26383-242P
C28	Cer 220pF 20% 500V	26383-134W
C29	Cer 0.001µF +80-20% 500V	26383-242P
C30	Cer 0.01µF +80-20% 100V	26383-055L

Circuit ref.	Description	Part no.
Unit A16 : Pre-amplifier, modulator, counter amplifier, wide band amplifier (continued)		
C31	Cer 0.001µF +80-20% 500V	26383-242P
C32	Cer 0.01µF +80-20% 100V	26383-055L
C33	Cer 0.001µF +80-20% 500V	26383-242P
C34	Cer 0.001µF +80-20% 500V	26383-242P
C35	Cer 0.001µF +80-20% 500V	26383-242P
C36	Cer 68pF 20% 500V	26343-163N
C37	Cer 82pF 10% 500V	26343-165J
C38	Cer 0.001µF +80-20% 500V	26383-242P
C39	Cer 18pF 20% 500V	26343-129L
C40	Cer 18pF 20% 500V	26343-129L
C41	Cer 0.001µF +80-20% 500V	26383-242P
C42	Cer 0.01µF +80-20% 100V	26383-055L
C43	Cer 0.01µF +80-20% 100V	26383-055L
C44	Cer 18pF 5% 63V	26343-468Y
C45†	Cer 2.2pF ±0.5pF 500V	26343-112P
C46 to † C49	Cer 0.001µF +80-20% 500V	26383-242P
C50	Cer 2.7pF ±0.5pF 500V	26343-109P
C51†	Cer 3.3pF 0.5% 500V	26343-111T

Circuit ref.	Description	Part no.
D1	HP5082-2811	28349-008U
D2	HP5082-2811	28349-008U
D7	HP5082-3080	28383-999X
D8	HP5082-3080	28383-999X
D9	HP5082-2835	28349-006H
D10	HP5082-2835	28349-006H
D3 D4 D5 D6	Order as a complete set	44529-007R
D11 D12 D13 D14		
L1	100µH 10%	23642-561W
L2	100µH 10%	23642-561W
L4	33µH 10%	23642-558W
R1	Met film 82Ω 2% 1/4W	24773-247N
R2	Met film 43Ω 1% 1/4W	24762-533Z
R3	Met film 100Ω 2% 1/4W	24773-249J
R4	Met film 6.8Ω 2% 1/4W	24773-221F
R5	Met film 270Ω 2% 1/4W	24773-259T

Unit A16 : Pre-amplifier, modulator, counter amplifier, wide band amplifier (continued)

Circuit ref.	Description	Part no.
R6	Met film 200Ω 2% 1/4W	24773-256S
R7	Met film 250Ω 2% 1/4W	24773-259T
R8	Met film 200Ω 2% 1/4W	24773-256S
R9†	Met film 39Ω 2% 1/4W	24773-239Z
R10	Met film 100Ω 2% 1/4W	24773-249J
R11	Met film 22Ω 2% 1/4W	24773-233W
R12	Met film 270Ω 2% 1/4W	24773-259T
R13	Met film 120Ω 2% 1/4W	24773-251L
R14	Met film 270Ω 2% 1/4W	24773-259T
R15	Met film 47Ω 2% 1/4W	24773-241A
R16	Met film 150Ω 2% 1/4W	24773-253F
R17	Met film 15kΩ 2% 1/4W	24773-301P
R18	Met film 15kΩ 2% 1/4W	24773-301P
R19	Met film 15Ω 2% 1/4W	24773-229X
R20	Met film 82Ω 2% 1/4W	24773-247N
R21	Carb 200Ω 2% 1/8W	24331-999A
R22†	Met film 68kΩ 2% 1/4W	24773-317N
R23	Met film 1kΩ 2% 1/4W	24773-273A
R24	Met film 470Ω 2% 1/4W	24773-265M
R25	Met film 5.6kΩ 2% 1/4W	24773-291S
R26	Met film 6.8kΩ 2% 1/4W	24773-293D
R27	Met film 200Ω 2% 1/4W	24773-256S
R28	Met film 390Ω 2% 1/4W	24773-263P
R29	Met film 15Ω 2% 1/4W	24773-229X
R30	Met film 56kΩ 2% 1/4W	24773-315U
R31	Met film 1kΩ 2% 1/4W	24773-273A
R32	Met film 82Ω 2% 1/4W	24773-247N
R33	Met film 200Ω 2% 1/4W	24773-256S
R34†	Met film 12kΩ 2% 1/4W	24773-299R
R35	Met film 430Ω 2% 1/4W	24773-264X
R36	Met film 82Ω 1% 1/4W	24762-569Y
R37	Met film 1kΩ 2% 1/4W	24773-273A
R38	Met film 560Ω 2% 1/4W	24773-267R
R40	Met film 22Ω 2% 1/4W	24773-233M
R41†	Met film 68Ω 2% 1/4W	24773-245U
R42	Met film 390Ω 2% 1/4W	24773-263P
T1	Transformer	43590-009G
T2	Transformer	43590-009G
TR1	Transistor BFR90	28452-167U
TR2	Transistor BFR90	28452-167U
TR3	Transistor BFY90	28452-157R
TR4	Transistor BFY90	28452-157R
TR5	Transistor BFR90	28452-167U
TR6	Transistor BFY90	28452-157R
TR7	Transistor BFY90	28452-157R
TR8	Transistor BFY90	28452-157R
X3	Ceramic bead	23213-146D

Unit A17 : ALC and a.m. driver

Circuit ref.	Description	Part no.
23.	When ordering, prefix circuit reference with A17.	
	Complete board	44827-153U
C1	Cer 0.01µF +80-20% 100V	26383-055L
C2	Cer 0.1µF +50-20% 30V	26383-031S
C3	Elec 22µF +100-20% 25V	26415-805K
C4	Elec 47µF +100-20% 40V	26415-810Z
C5	Elec 47µF +100-20% 40V	26415-810Z
C6	Elec 10µF +100-20% 63V	26415-802C
C7	Plas 2.2µF 10% 63V	26582-418Z
C8	Cer 100pF 20% 500V	26343-167G
C9	Cer 100pF 20% 500V	26343-167G
C10	Cer 0.01µF +80-20% 100V	26383-055L
C11	Elec 22µF 20% 15V	26486-583L
C12	Cer 100pF 20% 500V	26343-167G
C13	Cer 100pF 20% 500V	26343-167G
C14 †	Plas 5500pF 2% 125V	26516-666X
D1	HP5082-2811	28349-008U
D2	HP5082-2811	28349-008U
D3	1N4148	28336-676J
D4	HP5082-2835	28349-006H
D5	HP5082-2835	28349-006H

Circuit ref.	Description	Part no.
IC1	µA741 (operational amplifier)	28461-304T
R1	Met film 1kΩ 2% 1/4W	24773-273A
R2	Met film 1kΩ 2% 1/4W	24773-273A
R3	Met film 4.7kΩ 2% 1/4W	24773-289W
R4	Met film 10kΩ 2% 1/4W	24773-297M
R5	Carb var. 220Ω 10% ½W	25711-546X
R6 †	Met film 560Ω 2% 1/4W	24773-267R
R7 †	Met film 390Ω 2% 1/4W	24773-263P
R9	Met film 22kΩ 2% 1/4W	24773-305R
R10	Met film 10kΩ 2% 1/4W	24773-297M
R12	Met film 5.6kΩ 2% 1/4W	24773-291S
R13	Met film 15kΩ 2% 1/4W	24773-301P
R14	Met film 1kΩ 2% 1/4W	24773-273A
R15	Met film 430Ω 2% 1/4W	24773-264X
R16	Met film 2.7kΩ 2% 1/4W	24773-283L
R17	Met film 1kΩ 2% 1/4W	24773-273A
R18	Met film 430Ω 2% 1/4W	24773-264X
R19	Met film 15kΩ 2% 1/4W	24773-301P
R20	Met film 2.2kΩ 2% 1/4W	24773-281Y
R21	Met film 4.3kΩ 2% 1/4W	24773-288S
R22	Met film 3.3kΩ 2% 1/4W	24773-285F
R23	Met film 36kΩ 2% 1/4W	24773-310K
R24	Met film 36kΩ 2% 1/4W	24773-310K
R25	Met film 8.2kΩ 2% 1/4W	24773-295P

Circuit ref.	Description	Part no.
Unit A17 : ALC and a.m. driver (continued)		
R26	Met film 8.2kΩ 2% 1/4W	24773-295P
R27	Met film 120kΩ 2% 1/4W	24773-323F
R28	Met film 12kΩ 2% 1/4W	24773-299R
R29	Met film 27kΩ 2% 1/4W	24773-307K
R30	Met film 47kΩ 2% 1/4W	24773-313H
R31	Met film 1.5kΩ 2% 1/4W	24773-277U
R32	Met film 6.2kΩ 2% 1/4W	24773-292W
R33	Met film 680Ω 2% 1/4W	24773-269K
R34	Met film 2kΩ 2% 1/4W	24773-280U
R35	Met film 5.6kΩ 2% 1/4W	24773-291S
R36	Met film 15kΩ 2% 1/4W	24773-301P
R37	Met film 27kΩ 2% 1/4W	24773-307K
R38	Met film 27kΩ 2% 1/4W	24773-307K
R39	Carb 470kΩ 5% 1/8W	24311-937A
R40	Carb 470kΩ 5% 1/8W	24311-937A
TR1	BCY71	28435-235L
TR2	BCY71	28435-235L
TR3	BC109	28452-777K
TR4	BC107	28455-437L
TR5	BC107	28455-437L
TR6	BC107	28455-437L
TR7	BC107	28455-437L
TR8	BCY70	28434-857Z
TR9	BCY70	28434-857Z
TR10	BCY70	28434-857Z

Unit A18 : Monitors

24. When ordering, prefix circuit reference with A18.

Circuit ref.	Description	Part no.
	Complete board	44827-154Y
C1	Plas 0.47µF 10% 63V	26582-410P
C2	Elec 22µF +100-20% 25V	26415-805K
C3	Plas 0.47µF 10% 63V	26582-410P
D1	1N4148	28336-676J
D2	1N4148	28336-676J
D3	1N4148	28336-676J
D4	1N4148	28336-676J
D5	1N4148	28336-676J
D6	1N4148	28336-676J
R1	Met film 1.1kΩ 2% 1/4W	24773-274Z
R2 †	Met film 3.3kΩ 2% 1/4W	24773-285F
R3	Var. cermet 2.5kΩ 10% ½W	25541-322T
R4	Met film 4.7kΩ 2% 1/4W	24773-289W
R5	Var. cermet 10kΩ 10% ½W	25711-543D

Circuit ref.	Description	Part no.
Unit A18 : Monitors (continued)		
R6	Met film 27kΩ 2% 1/4W	24773-307K
R7	Met film 220kΩ 2% 1/4W	24773-329T
R8	Met film 2.2kΩ 2% 1/4W	24773-281Y
R9	Thermistor 1.5kΩ (CZ3)	25683-644G
R10	Met film 680Ω 2% 1/4W	24773-269K
R11	Met film 1.5kΩ 2% 1/4W	24773-277U
R12	Met film 10kΩ 2% 1/4W	24773-297M
R13	Met film 3.3kΩ 2% 1/4W	24773-285F
R14	Met film 4.7kΩ 2% 1/4W	24773-289W
R15	Met film 4.3kΩ 2% 1/4W	24773-288S
R16	Met film 3.9kΩ 2% 1/4W	24773-287V
R17	Var cermet 47kΩ 10% ½W	25711-549R
R18	Met film 5.1kΩ 2% 1/4W	24773-290V
R19	Met film 2.2kΩ 2% 1/4W	24773-281Y
R20	Met film 8.2kΩ 2% 1/4W	24773-295P
R21	Met film 10kΩ 2% 1/4W	24773-297M
R22	Var cermet 220Ω 10% ½W	25711-546X
R23	Var cermet 1kΩ 10% ½W	25711-544T
R24	Met film 15kΩ 2% 1/4W	24773-301P
R25	Met film 10kΩ 2% 1/4W	24773-297M
R26	Met film 2.2kΩ 2% 1/4W	24773-281Y
TR1	BC108	28452-787N
TR2	BC109	28452-777K

Unit A19 : Modulation oscillator and f.m. drive

25. When ordering, prefix circuit reference with A19.

Circuit ref.	Description	Part no.
	Complete board	44827-155N
C1	Plas 0.018µF 2% 125V	26516-786N
C2	Plas 0.018µF 2% 125V	26516-786N
C3	Elec 22µF +100-20% 25V	26415-805K
C4	Cer 0.047µF +50-20% 30V	26383-018Y
C5	Elec 22µF +100-20% 25V	26415-805K
C6	Plas 0.47µF 10% 63V	26582-410P
C7	Tant 100µF 20% 10V	26486-606B
C8	Tant 100µF 20% 10V	26486-606B
C9	Tant 22µF 20% 15V	26486-583L

Circuit ref.	Description	Part no.
Unit A19 : Modulation oscillator and f.m. drive (continued)		
R1	Met film 18kΩ 2% 1/4W	24773-303M
R2	Met film 18kΩ 2% 1/4W	24773-303M
R3	Met film 2.2kΩ 2% 1/4W	24773-281Y
R4	Met film 680Ω 2% 1/4W	24773-269K
R5	Met film 22kΩ 2% 1/4W	24773-305R
R6	Met film 9.1kΩ 2% 1/4W	24773-296X
R7	Thermistor 50kΩ (RA54)	25683-387Z
R8	Met film 1kΩ 2% 1/4W	24773-273A
R9	Met film 100kΩ 2% 1/4W	24773-321L
R10	Met film 560Ω 2% 1/4W	24773-267R
R11	Met film 6.8kΩ 2% 1/4W	24773-293D
R12	Var. carb 2.5kΩ 20% 0.21W	25541-322T
R15 †	Met film 82kΩ 2% 1/4W	24773-319J
R16	Met film 220kΩ 2% 1/4W	24773-329T
R17	Met film 10kΩ 2% 1/4W	24773-297M
R18	Met film 100Ω 2% 1/4W	24773-249J
R19	Met film 100Ω 2% 1/4W	24773-249J
R20	Met film 100Ω 2% 1/4W	24773-249J
R21	Met film 100Ω 2% 1/4W	24773-249J
R22 †	Met film 240Ω 2% 1/4W	24773-258D
R23 †	Met film 22kΩ 2% 1/4W	24773-305R
R25	Met film 220Ω 2% 1/4W	24773-257W
R26	Met film 9.1kΩ 2% 1/4W	24773-296X
R27	Met film 10kΩ 2% 1/4W	24773-297M
R28	Met film 2.2kΩ 2% 1/4W	24773-281Y
R29 †	Met film 220Ω 2% 1/4W	24773-257W
R30 †	Met film 270Ω 2% 1/4W	24773-259T
TR1	BC108	28452-787N
TR2	BCY71	28435-235L
TR3	BCY71	28435-235L
TR4	BC108	28452-787N
TR5	BC108	28452-787N
Unit A20 : Power supply		
26.	When ordering, prefix circuit reference with A20.	
	Complete board	44827-105X
C2	Elec 100µF +100-20% 25V	26423-244C
C3	Cer 0.0047µF +80-20% 100V	26383-321K
C4	Tant 4.7µF 20% 35V	26486-219P
C5	Elec 100µF +100-20% 25V	26423-243M
C6	Cer 0.01µF +100-20% 100V	26383-055L
C7	Plas 1µF 10% 63V	26582-414R
C8	Plas 2.2µF 10% 63V	26582-418Z
C9	Cer 0.1µF +50-20% 30V	26383-031S

Circuit ref.	Description	Part no.
Unit A20 : Power supply (continued)		
D1	1N4004	28357-028K
D2	1N4004	28357-028K
D3	1N4004	28357-028K
D4	1N4004	28357-028K
D5	Zener BZY88C8V2	28371-679V
D7	1N4004	28357-028K
R1	Met film 1kΩ 2% 1/4W	24773-273A
R2	Met film 2.2kΩ 2% 1/4W	24773-281Y
R3	Met film 12kΩ 2% 1/4W	24773-299R
R4	Preset 2.2kΩ 20% 0.21W	25711-547M
R5	Met film 7.5kΩ 2% 1/4W	24773-294T
R6	Met film 2.2kΩ 2% 1/4W	24773-281Y
R7	Met film 1.5kΩ 2% 1/4W	24773-277U
R8	Met film 24kΩ 2% 1/4W	24773-306B
R9 †	Met film 2.7kΩ 2% 1/4W	24773-283L
R10 †	Met film 6.8kΩ 2% 1/4W	24773-293D
R11	Met film 2.2kΩ 2% 1/4W	24773-281Y
R12	Met film 100Ω 2% 1/4W	24773-249J
R13	Met film 13kΩ 2% 1/4W	24773-300T
R14 †	Met film 3kΩ 2% 1/4W	24773-284J
R15	Met film 100Ω 2% 1/4W	24773-249J
R16	Met film 3.3kΩ 2% 1/4W	24773-285F
R17 †	Met film 10kΩ 2% 1/4W	24773-297M
R18	WW 1.5kΩ 5% 1.5W	25123-084F
R19	Met film 5.1kΩ 2% 1/4W	24773-290V
TR2	BFY51	28455-827T
TR3	BC108	28452-787N
TR4	MM4001	28438-436V
TR5	BCY71	28435-235L
TR6 †	BF244B (complete with matched resistors R9 & R10)	46883-258T
TR7	BC239C	28452-771P
TR8	BC239C	28452-771P
Unit A21 : Fine tuning		
27.	When ordering, prefix circuit reference with A21.	
	Complete board	44827-222E
C1	Plas 0.47µF 10% 63V	26582-410P
C2	Tant 22µF 20% 15V	26486-583L
C3	Plas 0.1µF 10% 100V	26582-211B
R1 †	Met film 6.8kΩ 2% 1/4W	24773-293D
R2	Met film 10kΩ 2% 1/4W	24773-297M
R4	Met film 2kΩ 2% 1/4W	24773-280U
R5	Met film 2kΩ 2% 1/4W	24773-280U

Circuit ref.	Description	Part no.
Unit A21 : Fine tuning (continued)		
R6	Met film 10kΩ 2% 1/4W	24773-297M
R7	Met film 220kΩ 2% 1/4W	24773-329T
R8	Met film 10kΩ 2% 1/4W	24773-297M
R9 †	Met film 150kΩ 2% 1/4W	24773-325V
R10	Carb 1MΩ 5% 1/8W	24311-945Y
R11	Carb 1MΩ 5% 1/8W	24311-945Y
TR1	BFW11	28459-012W
Unit A22 : Coarse r.f. output (attenuator)		
28.	When ordering, prefix circuit reference with A22.	
	Complete board	44429-026E
C1	Cer 0.01µF 20% 50V	26346-115E
C2	Cer 0.01µF 20% 50V	26346-115E
CAM	10dB	31359-022D
CAM	20/1dB	31359-021W
CAM	20/2dB	31359-019D
CAM	30/1dB	31359-018W
CAM	30/2dB	31359-020S
D1	Diode assembly PIN/NIP	28383-990J
R1	Met film 790Ω 1% 1/4W	24762-646F
R2	Met film 790Ω 1% 1/4W	24762-646F
R3	Met film 247Ω 1% 1/4W	24762-631R
R4	Met film 247Ω 1% 1/4W	24762-631R
R5	Met film 71.2Ω 1% 1/4W	24762-572Y
R6	Met film 53.3Ω 1% 1/4W	24762-557C
R7	Met film 53.3Ω 1% 1/4W	24762-557C
R8	Met film 53.3Ω 1% 1/4W	24762-557C
R9	Met film 53.3Ω 1% 1/4W	24762-557C
R10	Met film 61.1Ω 1% 1/4W	24762-571U
R11	Met film 61.1Ω 1% 1/4W	24762-571U
R12	Met film 61.1Ω 1% 1/4W	24762-571U
R13	Met film 61.1Ω 1% 1/4W	24762-571U
R14	Met film 96.3Ω 1% 1/4W	24762-582S
R15	Met film 96.3Ω 1% 1/4W	24762-582S
SA	Microswitch UHF	23483-131A
SB	Microswitch UHF	23483-131A
SC	Microswitch UHF	23483-131A
SD	Microswitch UHF	23483-131A
SE	Microswitch UHF	23483-131A
SF	Microswitch UHF	23483-131A
SG	Microswitch UHF	23483-131A
SH	Microswitch UHF	23483-131A
SJ	Microswitch UHF	23483-131A
SK	Microswitch UHF	23483-131A

Circuit ref.	*Description*	*Part no.*
Unit A23 : FM predistortion - temperature compensation		
29.	When ordering, prefix circuit reference with A23.	
	Complete board	44827-366G
C1	Tant 4.7µF 20% 35V	26486-219P
C2	Tant 4.7µF 20% 35V	26486-219P
D1	1N4148	28336-676J
D2	1N4148	28336-676J
R1	Carb film 680kΩ 5% 1/8W	24311-941Z
R2	Met film 10kΩ 2% 1/4W	24773-297M
R3	Met film 100kΩ 2% 1/4W	24773-321L
R4	Met film 56kΩ 2% 1/4W	24773-315U
R5	Met ox 820kΩ 2% 1/2W	24573-143W
R6	Met ox 330kΩ 2% 1/2W	24573-133N
R7	Assembly 270Ω	44359-003Y
R8	Met film 220Ω 2% 1/4W	24773-257W
R9	Met film 560Ω 2% 1/4W	24773-267R
R10	Thermistor CZ3 1.5kΩ	25683-644G
R11†	Met film 820Ω 2% 1/4W	24773-271B

Item	*Description*	*Part no.*
Mechanical parts		
30.	Order without prefix.	
	Note...	
	Item Nos. refer to Fig. 1. Screws, nuts and washers shown in Fig. 1 are not normally supplied with their associated components: where such fasteners are of a special type these are listed and may be ordered separately.	
Fig. 1 Item		
1	Top cover, excluding handle	41690-081A
2	Retaining clip (1 of 2) included in item 1	35418-311J
3	Protective clip (1 of 2)	37553-506Y
	Handle assembly comprising:-	
4	Plastic section	22315-575F
5	Liner (1 of 2)	22315-572N
6	End cap (1 of 2)	22315-573L
7	Special nut (1 of 2)	33900-120K
8	Bottom cover	35900-946K
9	Protective clip (1 of 2)	37553-506Y
10	Foot (1 of 4)	22315-604E
11	Special washer	33900-438J
	Handle assembly comprising:-	
12	Handle	37587-925L
13	Attachment	37588-110B

Item	Description	Part no.
14	Plate	34167-605B
15	Strip	21851-463E
16	Trim (left side)	34900-191Z
17	Trim (right side)	34900-192H
18	Protective cover, including catches	41690-102S
19	Catch (1 of 2)	22315-102V
20	Corner pad (1 of 4)	37575-123A
21	Surround	41511-018K
22	Front panel	35903-218Z
	Knobs:-	
23	CARRIER RANGE	41145-407B
24	TUNE	41149-014U
25	EXTRA FINE TUNE	41149-016N
26	FINE TUNE	41141-708K
27	FUNCTION	41145-407B
28	DEVIATION	41149-002M
29	RF OUTPUT (coarse)	41145-407B
30	AM DEPTH	41149-002M
	RF OUTPUT (fine)	41149-002M
	SET MOD	41149-002M
34	Window	37490-020W
35	Scale 10-14.3MHz	31759-004L
	14.3-20.5MHz	31759-005J
	20.5-29.9MHz	31759-006F
	29.4-42MHz	31759-007G
	42-60MHz	31759-008V
	60-86MHz	31759-009S
	86-124MHz	31759-010G
	124-177MHz	31759-011V
	177-254MHz	31759-012S
	254-363MHz	31759-014D
	363-520MHz	31759-021M
36	RF box lid	41690-015Z
37	Switch cover	37490-065A
38	Locking plate for mains selector	34444-116Y
	Tuning drive parts (see Chap.5, Fig.8)	
	Drive cord	16410-604V
	Tension spring	31119-017X
	Cursor assembly	41179-001R

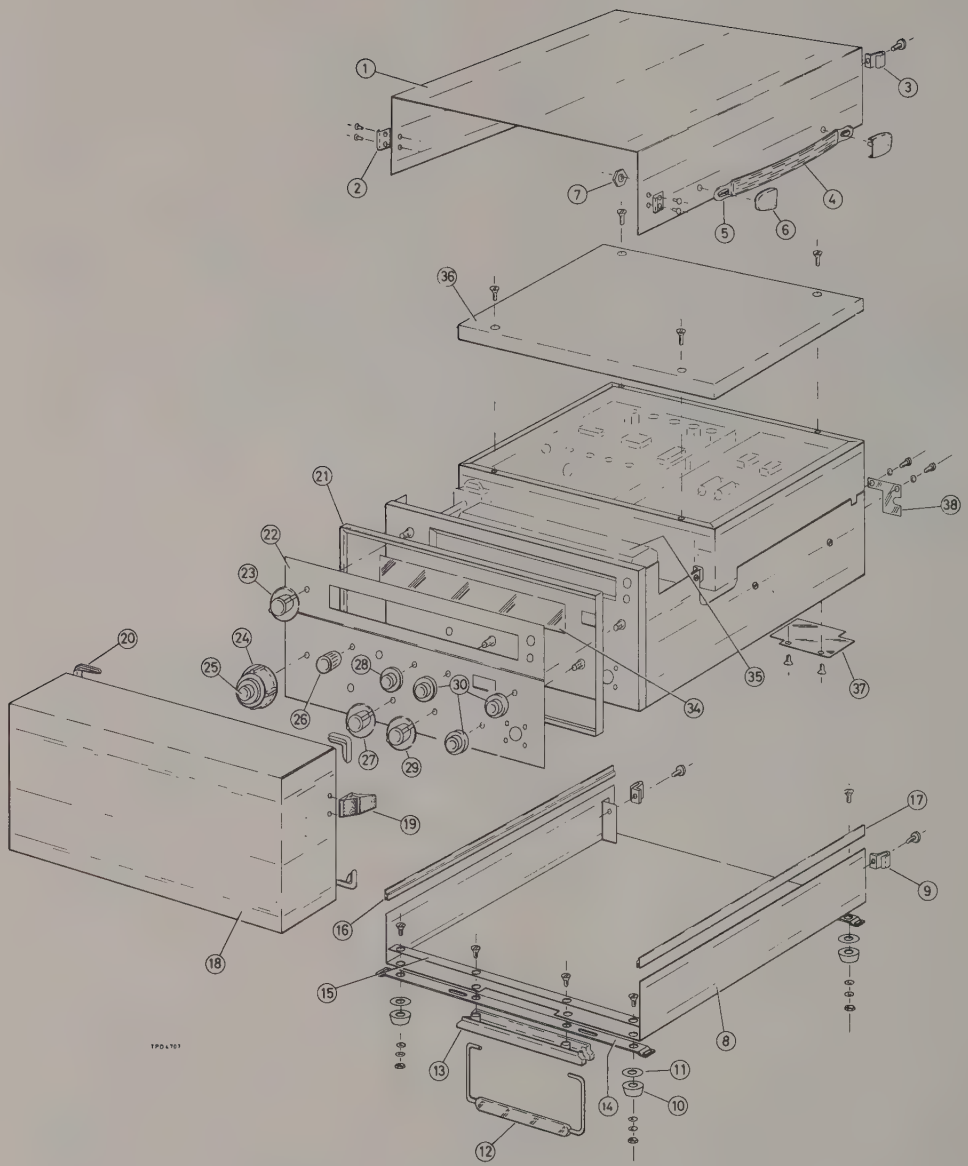


Fig. 1 TF 2015A - Mechanical parts

INDEX TO UNITS

31. The following list identifies the Unit, Marconi Instruments Part number, description, parts list location and also location in Chap. 7.

Unit No.	*Part no.*	*Description*	*Parts list page*	*Circuit diagram Chap. 7, Fig.*
A0	-	Chassis and panel components	4	A11
A1	44827-137X	Oscillator range 1	6	2
A2	44827-138M	Oscillator range 2	7	2
A3	44827-139C	Oscillator range 3	7	2
A4	44827-140X	Oscillator range 4	8	2
A5	44827-141M	Oscillator range 5	8	2
A6	44827-142C	Oscillator range 6	9	2
A7	44827-143R	Oscillator range 7	9	2
A8	44827-144B	Oscillator range 8	10	2
A9	44827-145K	Oscillator range 9	10	2
A10	Part of A12	Oscillator range 10	11	2
A11		Oscillator range 11	11	2
A12	44827-148H	Mother board	12	2
A16	44827-152E	Pre-amplifier, modulator, counter amplifier, wide band amplifier	13	3
A17	44827-153U	ALC and a.m. driver circuits	16	3
A18	44827-154Y	Monitors	17	1
A19	44827-155N	Modulation oscillator and f.m. drive	18	1
A20	44827-105X	Power supply	19	1
A21	44827-222E	Fine tuning circuits	20	1
A22	44429-026E	Coarse r.f. output (attenuator)	21	3
A23	44827-366G	Predistortion circuits	22	1

.....

Chapter 7

CIRCUIT DIAGRAMS

CONTENTS

Para.
1 Circuit notes

Fig. Page
1 Tuning, modulation, monitors and power supply circuit diagram 3/4
2 RF oscillators circuit diagram 5/6
3 Amplifiers, a.l.c. and attenuator circuit diagram 7/8

CIRCUIT NOTES

1. Component values

Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.
Inductors : No suffix = henrys, m = millihenrys, μ = microhenrys.
SIC : value selected during test, nominal value shown.

2. Symbols

arrow indicates clockwise rotation of knob.

etc., external front or rear panel marking.

tag on printed board.

unit identification number.

3. Circuit references

These are, in general, given in abbreviated form. See also introduction to Chap. 6.

4. Switches

Rotary switches are drawn schematically.
Letters or figures indicate control knob settings.
1F = 1st section (front panel), front.
1B = 1st section, back
2F = 2nd section, front.
etc.

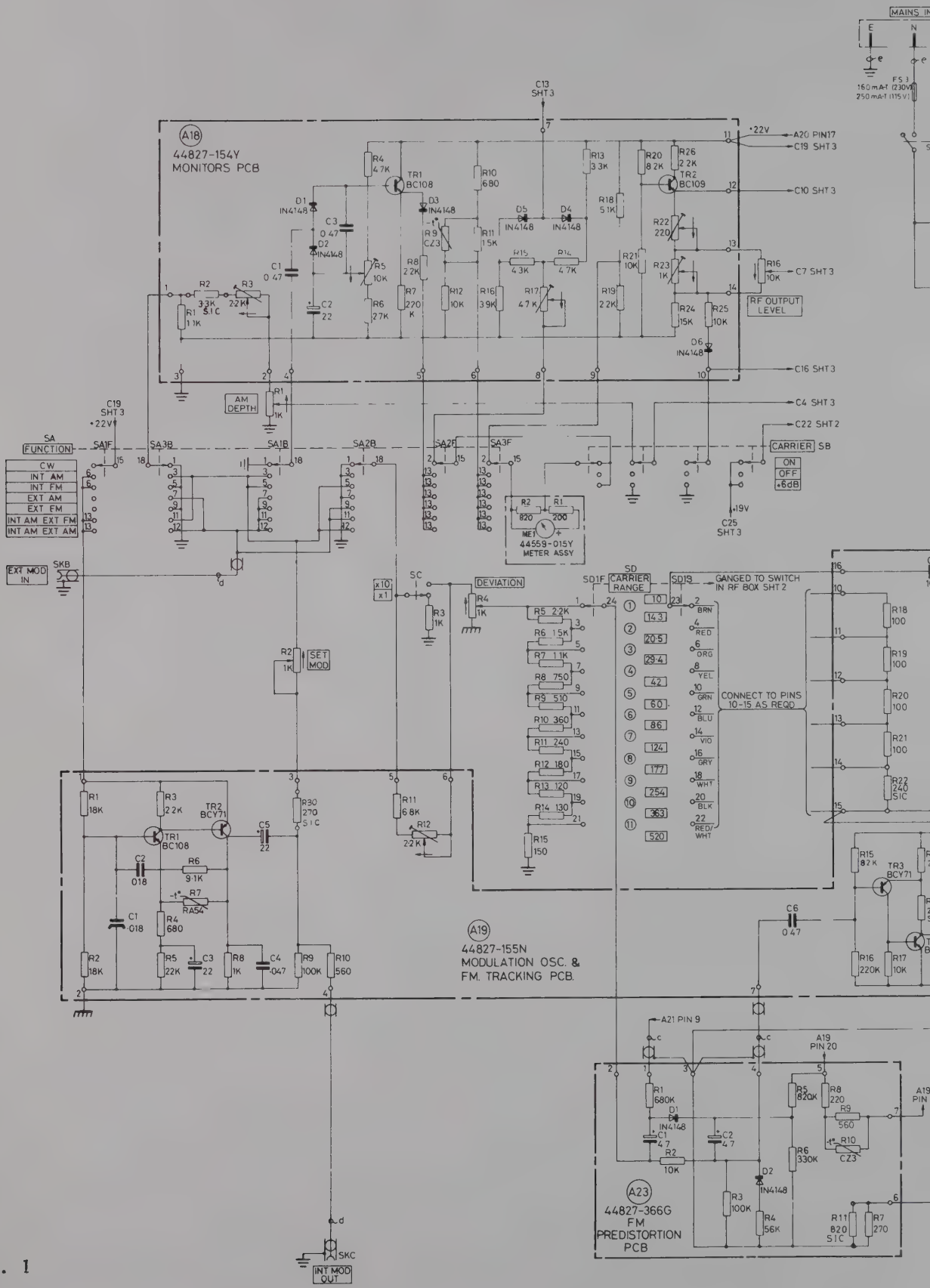
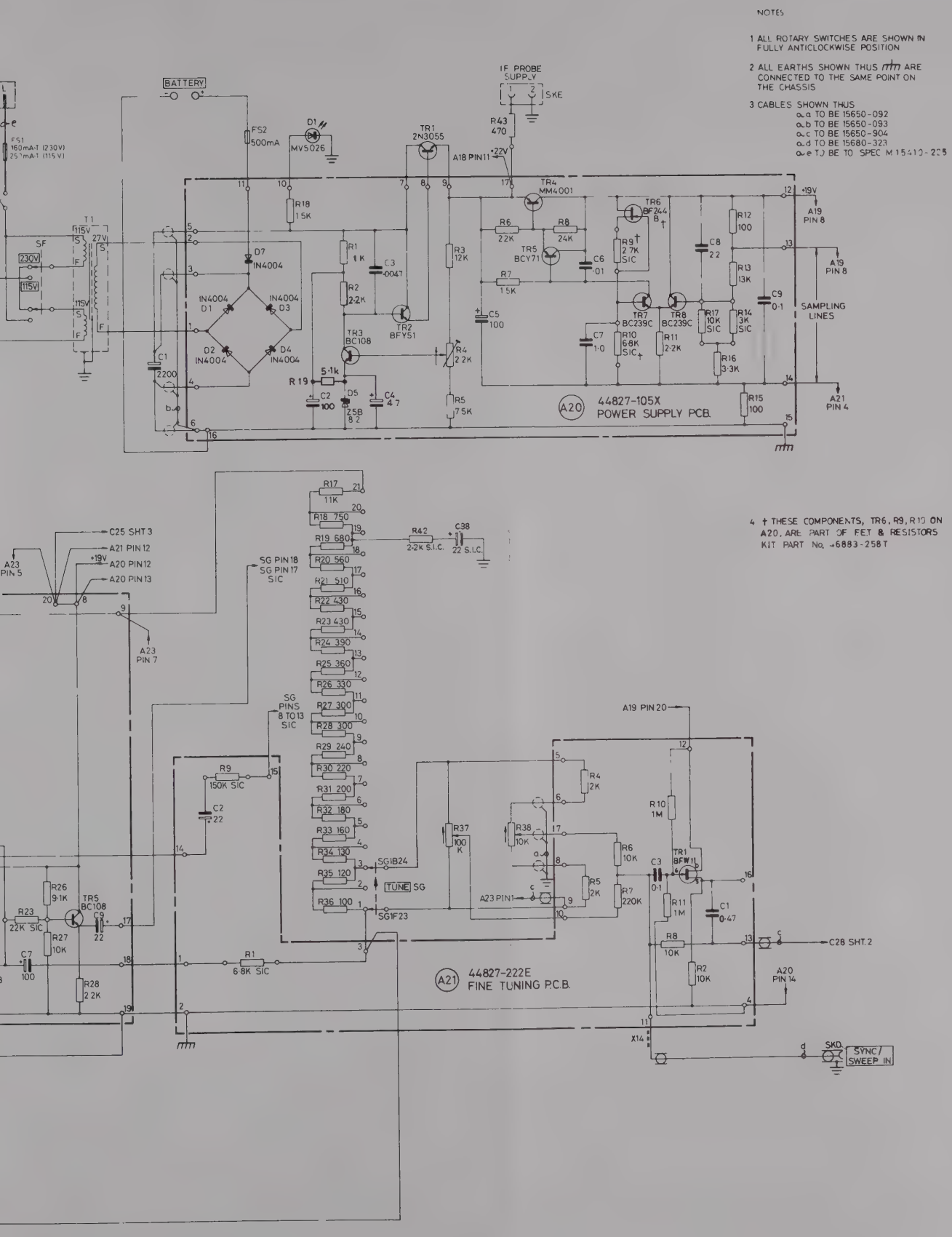
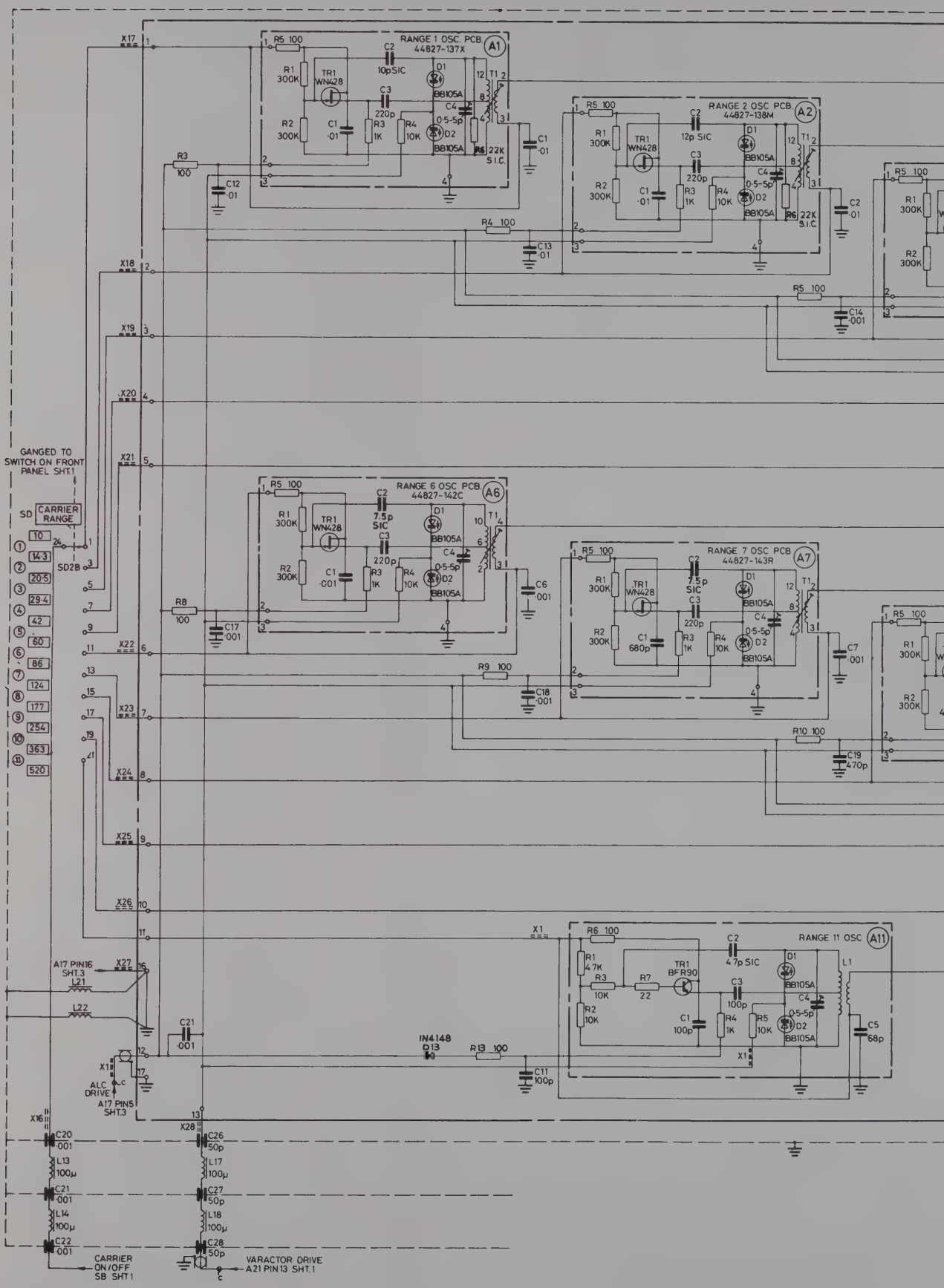

A18
44827-154Y
MONITORS PCB
A19
44827-155N
MODULATION OSC. &
FM. TRACKING PCB.
A23
44827-366G
FM
PREDISTORTION
PCB
44559-015Y
METER ASSY
SA
FUNCTION
CW
INT AM
INT FM
EXT AM
EXT FM
INT AM EXT FM
INT AM EXT AM
AM DEPTH
SET MOD
DEVIATION
CARRIER RANGE
CONNECT TO PINS 10-15 AS REQD
RF OUTPUT LEVEL
CARRIER
ON
OFF
+6dB
EXT MOD IN
INT MOD OUT
SKB
SKC
MAINS IN
TR1 BC108
TR2 BC109
TR2 BCY71
TR3 BCY71
+22V
+19V

Fig. 1

Apr. 82



Tuning, modulation, monitors and power supply circuit diagram.


RANGE 1 OSC. PCB. 44827-137X A1
RANGE 2 OSC. PCB. 44827-138M A2
RANGE 6 OSC. PCB. 44827-142C A6
RANGE 7 OSC PCB 44827-143R A7
RANGE 11 OSC A11
GANGED TO SWITCH ON FRONT PANEL SHT.1
SD CARRIER RANGE
SD2B
ALC DRIVE
A17 PIN5 SHT.3
A17 PIN16 SHT.3
IN4148
CARRIER ON/OFF SB SHT.1
VARACTOR DRIVE A21 PIN13 SHT.1

RF oscillators

Fig. 2

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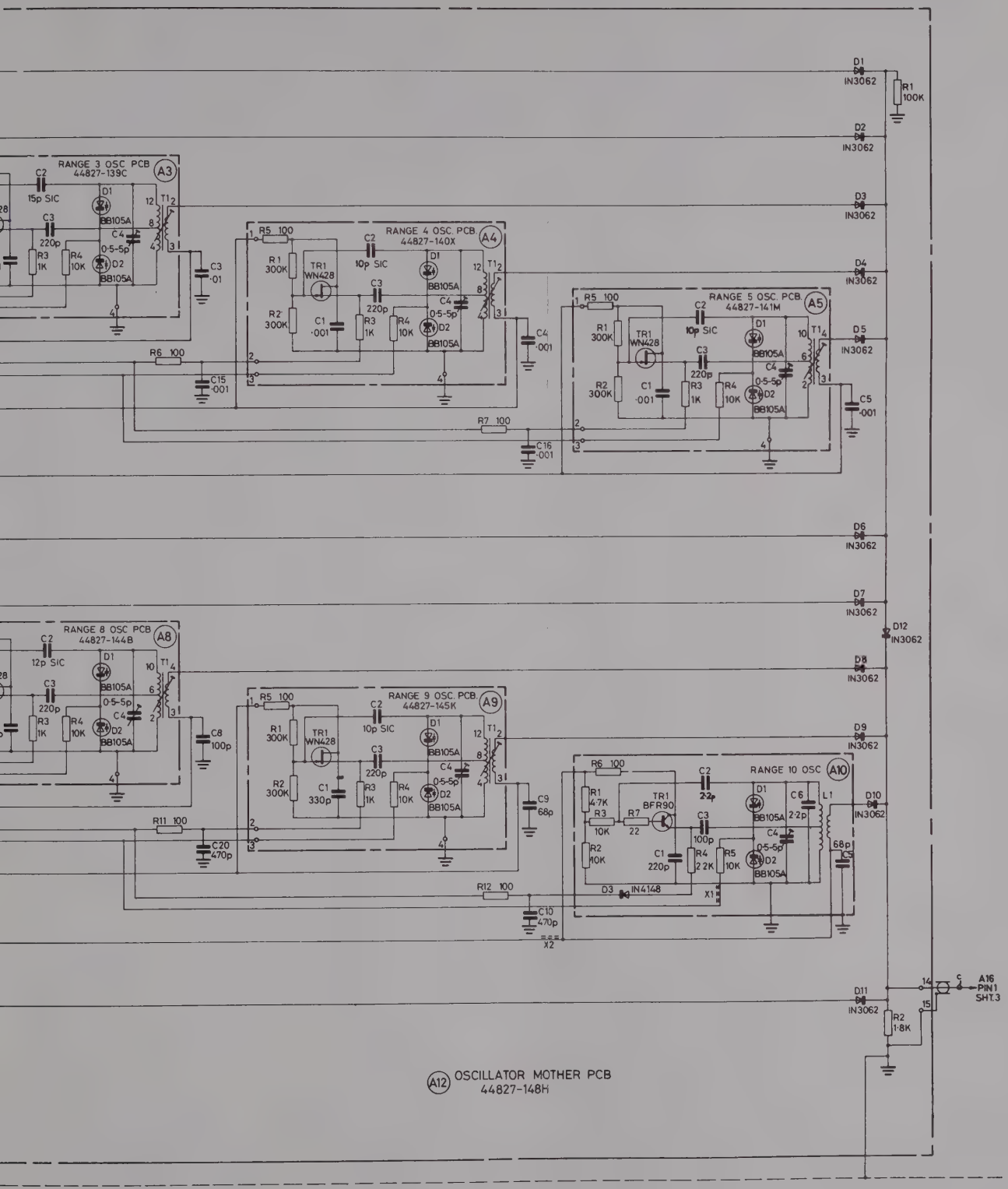
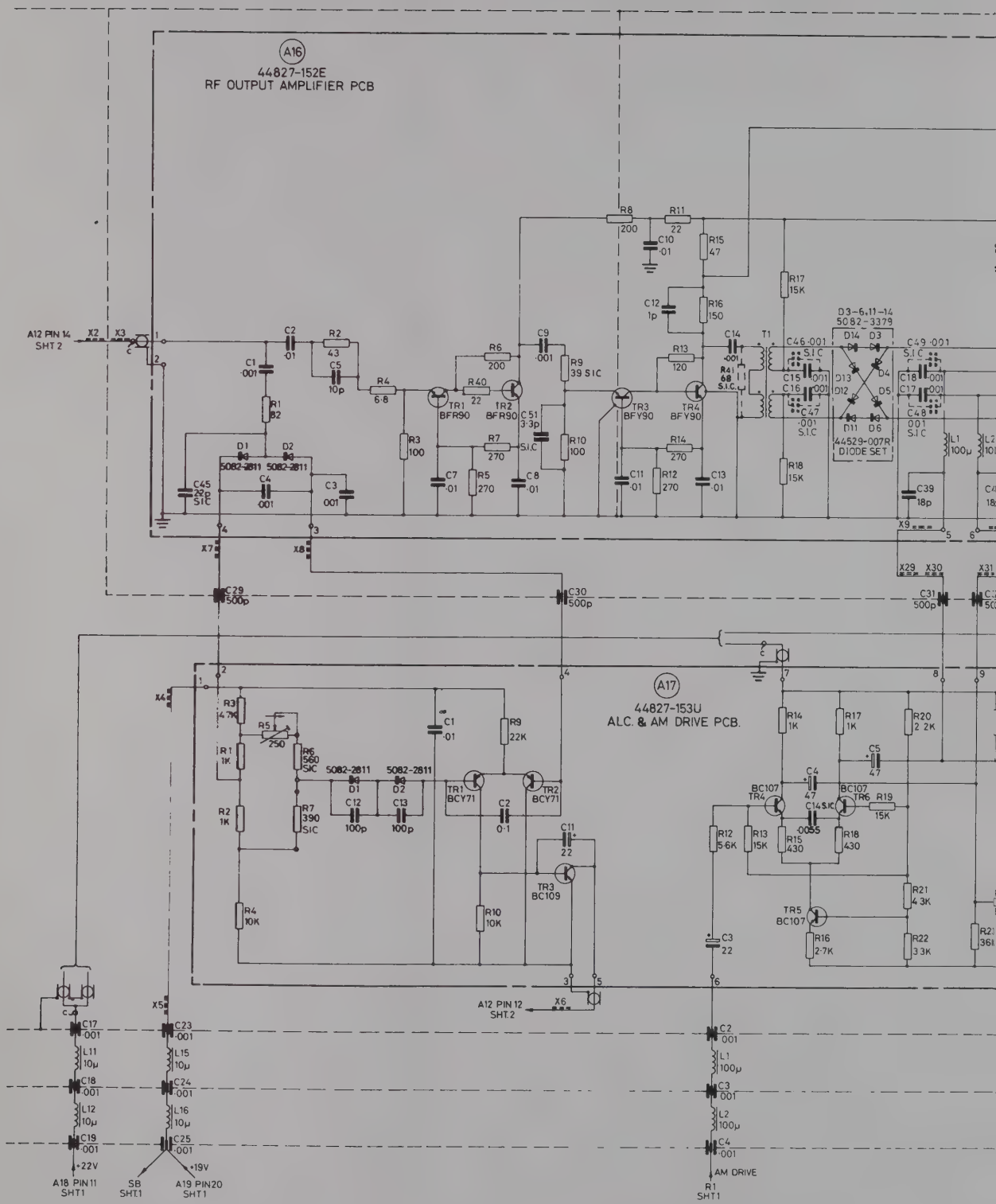


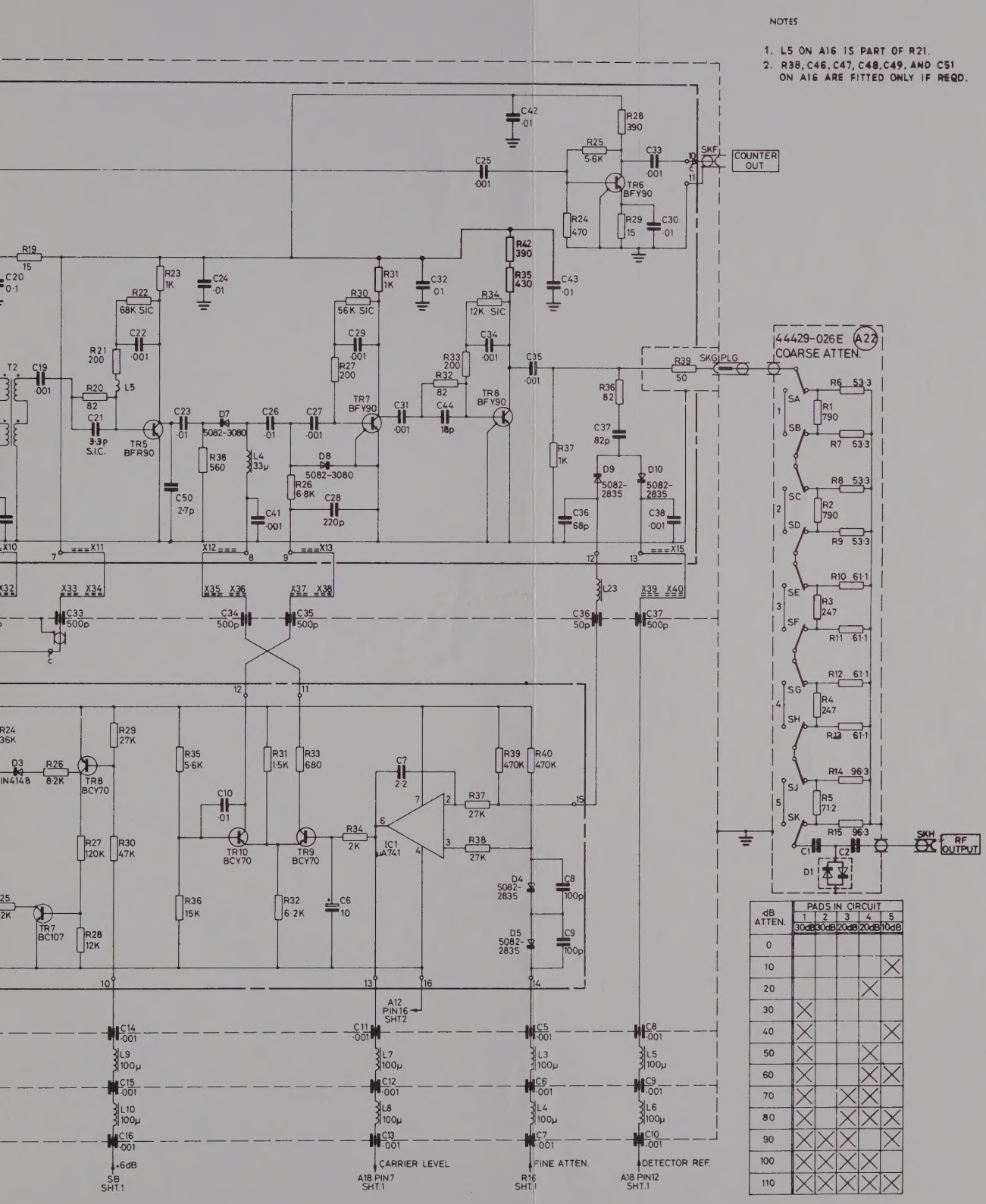
ircuit diagram.



Amplifiers, a.l.c. and a

Fig. 3

Apr. 82



dB ATTEN.	PADS IN CIRCUIT 1 30dB	2 30dB	3 20dB	4 20dB	5 10dB
0					
10					X
20				X	
30	X				
40	X				X
50	X			X	
60	X			X	X
70	X		X	X	
80	X		X	X	X
90	X	X	X		X
100	X	X	X	X	
110	X	X	X	X	X

ttenuator circuit diagram.

TF 2015

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